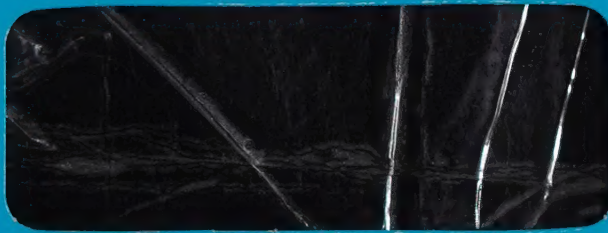


Operating Instructions





S1374**BRUSH 280
RECORDER
ALL MODELS**

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ADDENDUM

The Brush 280 Recorder Model 15-6327-101374 is a standard unit with the following exceptions:

1. Unit is modified to incorporate amplifier board 782381 (see schematic 282399 in rear of manual).
2. Board asm 682480 (Q-107A & B) replaces Q-107 and Q-108 on Pen Drive Amplifier Asm 846461.
3. Resistor 25-265969-50000 replaces R-310 on amplifier asm 843879.
4. Pen position controls R-11 and R-12 are replaced by part number 261080-103.
5. Paragraph 7.2.b in Calibration Section should read:

Insert a three conductor phone plug, with tip and body shorted and sleeve left open, into the Drive Amplifier (Fig. 7-2) and adjust the INTERNAL POSITION control until pen is exactly at chart center.
6. Unit is wired per schematic 482400.

ATTACHMENT TO NSP 1374

INSTALL INVERTING AMPLIFIER AND D.C. PEN POSITION

1. Remove terminal strip number 646867 that includes a separately mounted variable resistor, (R-9, 2K ohm multi-turn potentiometer). In place of this strip install Network Asm Board 882381 on the same mounting posts. This board includes all the components from the strip.
2. A new wire, (7)(3 ft, approx) must be run up from the choke, (L-8), in the negative supply. Ty wrap new wire to harness.
3. Remove from each channel demodulator (95) (913) lead wires and connect to output of new board. Then add new (95) (913) lead wires from input of new board to same terminals on Network Asm Board. (KEEP CHANNEL IDENTIFICATION).
4. Since this amplifier addition is inverting chopper drive must be reversed. Interchange the (4) and (0) wire from the Network Asm Board.
5. Remove C-309 from each 846474 board. Also remove shielded cable from preamplifier board. Then remove 250K ohm pen position pots from front panel and replace with D.C. pots 10K ohm wired back to D.C. excitation and amplifiers input. (KEEP CHANNEL IDENTIFICATION) located on board 882381.
6. Change 10K ohm resistor, R-310, 1%, to a 5K ohm Dale, .25% (Film). This is to be found on preamplifier board top edge just below 33ufd, 12V condenser.
7. Readjust gain and calibrate unit. Modification is now complete.

ELECTRICAL PARTS LIST AMPLIFIER BOARD 782381

QTY	DESCRIPTION	BRUSH PART NUMBER
1	Resistor	5-115557-333
1	Resistor	5-115557-122
2	Resistor	5-115557-821
1	Resistor	5-115557-102
2	Resistor	25-265969-20001
2	Resistor	25-265969-68001
2	Resistor	25-265969-40001
1	Resistor	1-128182-3301
1	Resistor	1-128182-1001
1	Resistor, Variable	244771-202
2	Capacitor	240352-251
1	Capacitor	231707-207
2	Integrated Circuit	230062
2	Zener Diode 1N751	241133
2	Zener Diode 1N4744	230061-2

TABLE OF CONTENTS

I	GENERAL INFORMATION	
1.1	Introduction	1.1
1.2	Specifications	1.2
1.3	Supplies and Accessories	1.3
II	INSTALLATION	
2.1	General	2.1
2.2	Incoming Inspection	2.1
2.3	Power Requirements	2.1
2.4	Outline Dimensions	2.1
III	SERVICING	
3.1	General	3.1
3.2	Chart Paper	3.1
3.3	Ink Supply	3.2
IV	OPERATION	
4.1	General	4.1
4.2	Control Description	4.1
4.3	Preliminary Operation	4.3
4.4	Using Calibrated Zero Suppression	4.3
V	THEORY OF OPERATION	
5.1	General	5.1
5.2	Detailed Description	5.1
VI	MAINTENANCE	
6.1	General	6.1
6.2	Case	6.1
6.3	Chart Takeup	6.2
6.4	Analog Pens	6.3
6.5	Event Marker Pens	6.4
6.6	Event Marker	6.5
6.7	Replacing Penmotor Band Assembly	6.6
6.8	Pen Pressure Measurement	6.6
6.9	Pen Pressure Adjustment	6.7
6.10	Pen Lapping	6.7
6.11	Lapping Procedures for Extended Life Pen	6.8
6.12	Optional Timer Installation	6.9
VII	CALIBRATION	
7.1	General	7.1
7.2	Calibration Procedure	7.1
7.3	Zero Suppression Calibration Procedure	7.5
VIII	TROUBLESHOOTING	
8.1	General	8.1
8.2	Troubleshooting Table	8.1
IX	PARTS IDENTIFICATION	
9.1	General	9.1

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Brush Recorders Mark 280 series are portable recording systems featuring 80-millimeter wide channels and frequency response essentially flat to 100 Hz, with full scale response beyond 35 Hz. In wide channels are combined the advantages of high frequency response, exceptional resolving power, and the ability to display usefully an inherent system accuracy of 1/2%. This accuracy is made possible by the Metrisite-controlled pen position servo system featured in recorders of the Brush Mark 200 series. The writing system employs pressurized fluid, producing traces of uniform clarity at all writing velocities.

Pen motion is rectilinear. Charts are graduated in 50 equal divisions. All solid-state amplifiers give sensitivity down to 0.5 millivolts/division. Recording range extends from ± 12.5 millivolts to ± 250 volts full scale. Inputs are floating and guarded, with input impedance of one megohm constant at all attenuator settings. High common mode rejection, insensitivity to source impedance, low noise, and excellent gain and zero line stability are notable characteristics.

Full functional control, including 8-step attenuation, variable gain, pen positioning, and push button event marking, is provided on the front panel. Adjustable electronic limit stops, which prevent pen damage by overloading, are standard. Two three-position event markers are provided. A third may be added between the channels at option.

Twelve chart speeds, from 0.05 millimeters per second to 200 millimeters per second are electrically controlled by pushbuttons.

Information in this manual applies to all Brush Recorders of the Mark 280 series. Except for power source, transmission assemblies, and differences listed below, both basic model series are identical.

without zero suppression	with zero suppression
15-6327-01 60 Hz	15-6327-10
15-6327-04 400 Hz	15-6327-14
15-6327-05 50 Hz	15-6327-15
15-6327-06 50 Hz 230 volts	15-6327-16



FIGURE 1-1 MARK 280 RECORDER

1.2 SPECIFICATIONS

This paragraph describes the specifications and data pertinent to all models of the Mark 280 Recorder, except where noted.

a. General

Number of Channels	2 Analog 2 Event (3 position) (A third event may be added at option)
Channel Width	80 millimeters, 50 divisions per channel
Trace Width	.01 inch nominal
Presentation	True rectilinear
Writing Method	Pressurized fluid closed system (U.S. Patent 3,054,109) from internal pump
Chart Capacity	High contrast paper - 275 feet Reproducible paper - 400 feet
Writing fluid capacity	2 oz; sufficient for approximately 50 rolls, normal recording
Principle dimensions	18-3/8 inches high, 10-1/2 inches wide, 11-1/2 inches deep
Calibration	Deflects pen 25 lines--checks operation and gain of drive amplifiers and preamplifiers. One volt internal source available at rear

b. Electrical

Sensitivity	0.5 millivolt/chart division
Measurement range	500 volt full scale
Signal input	1 megohm impedance, constant; floating, guarded
Noise	0.2 division, peak-to-peak with 100 Kohm source impedance, any attenuator position.
Linearity	±0.5% full scale, a-c and d-c
Hysteresis	Less than 0.1% full scale
Frequency response (flat within 2%) (Fig. 1-2)	50 div peak-to-peak, to 35 Hz 25 div peak-to-peak, to 60 Hz 10 div peak-to-peak, to 100 Hz 2.5 div peak-to-peak, to 200 Hz
Repeatability	Better than 0.1% full scale
Typical coefficients	Temperature: 0.06%/°C 20-40°C range
Common mode rejection	120 dB, d-c; Maximum input voltage, ±500 volts

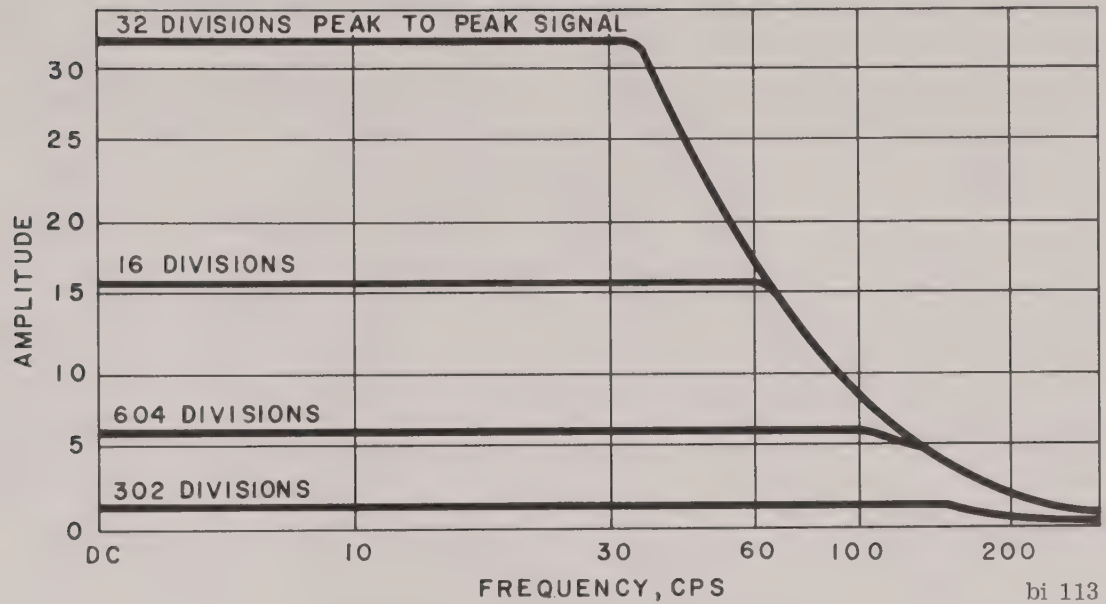


FIGURE 1-2 FREQUENCY RESPONSE

Zero Suppression Plus or minus 1 or 10 volts, with x1/x100 switch
 15-6327-10 and 15-6327-15 only in x1 position. Plus or minus 100 or 1000 volts with
 x1/x100 switch in x100 position. Continuously
 calibrated in 500 dial divisions readable to 1 part in 100
 Stability: 0.01%
 Accuracy: Within 1% of full scale suppression

Power Requirement

15-6327-01	115 volts $\pm$ 10%, 60 Hz, 200 watts
15-6327-10	
15-6327-04	115 volts $\pm$ 10%, 400 Hz, 275 watts
15-6327-14	
15-6327-05	115 volts $\pm$ 10%, 50 Hz, 200 watts
15-6327-15	
15-6327-06	230 volts $\pm$ 10%, 50 Hz, 200 watts
15-6327-16	

1.3 SUPPLIES AND ACCESSORIES

The supplies and accessories listed below will provide continuing peak performance of the Brush Mark 280 Recorder.

11-2923-20	Chart Paper, High Contrast, 275 feet per roll
11-2923-40	Chart Paper, Reproducible, 400 feet per roll
RA 2823-31	Pen, Analog

GENERAL INFORMATION

11-2823-34	Pen, Analog, Extended Life
RA 2821-20	Pen, Event
11-2734-02	Ink, Blue, 2 oz tube
RA 2103-90	Interchannel Event Marker
11-6405-00	Mobile Cart
11-6402-00	External Chart Take-Up
11-6101-20	One Second Timer
11-6101-40	One Minute Timer
341409-915	Band Replacement Tool
240601-910	Gram Gage Asm
1-120922-2	Wrench, Pen Pressure Adjustment
1-120922-18	Wrench, Pen Replacement
1-120922-3	Wrench, Band Replacement (Bristol)
245218-5	Wrench, Band Replacement (Hex)
2-247187-1	Calibration Cable
448411	Dust Cover

SECTION II

INSTALLATION

2.1 GENERAL

This section provides inspection procedures and contains power requirements and outline dimensions for the Mark 280 series Recorder.

2.2 INCOMING INSPECTION

1. Visually inspect unit for damage which may have occurred during shipment.
2. Check for loose cable connections.
3. Perform preliminary operation as described in Paragraph 4.3.

2.3 POWER REQUIREMENTS

When installing the Mark 280 Recorder, use the power listed below for that particular model.

15-6327-01	115 volts $\pm 10\%$ a-c, 60 Hz
15-6327-10	200 watts
15-6327-04	115 volts $\pm 10\%$ a-c, 400 Hz
15-6327-14	275 watts
15-6327-05	115 volts $\pm 10\%$ a-c, 50 Hz
15-6327-15	200 watts
15-6327-06	230 volts $\pm 10\%$ a-c, 50 Hz
15-6327-16	200 watts

2.4 OUTLINE DIMENSIONS

Refer to Figure 2-1 for dimensions of the Mark 280 Recorder.

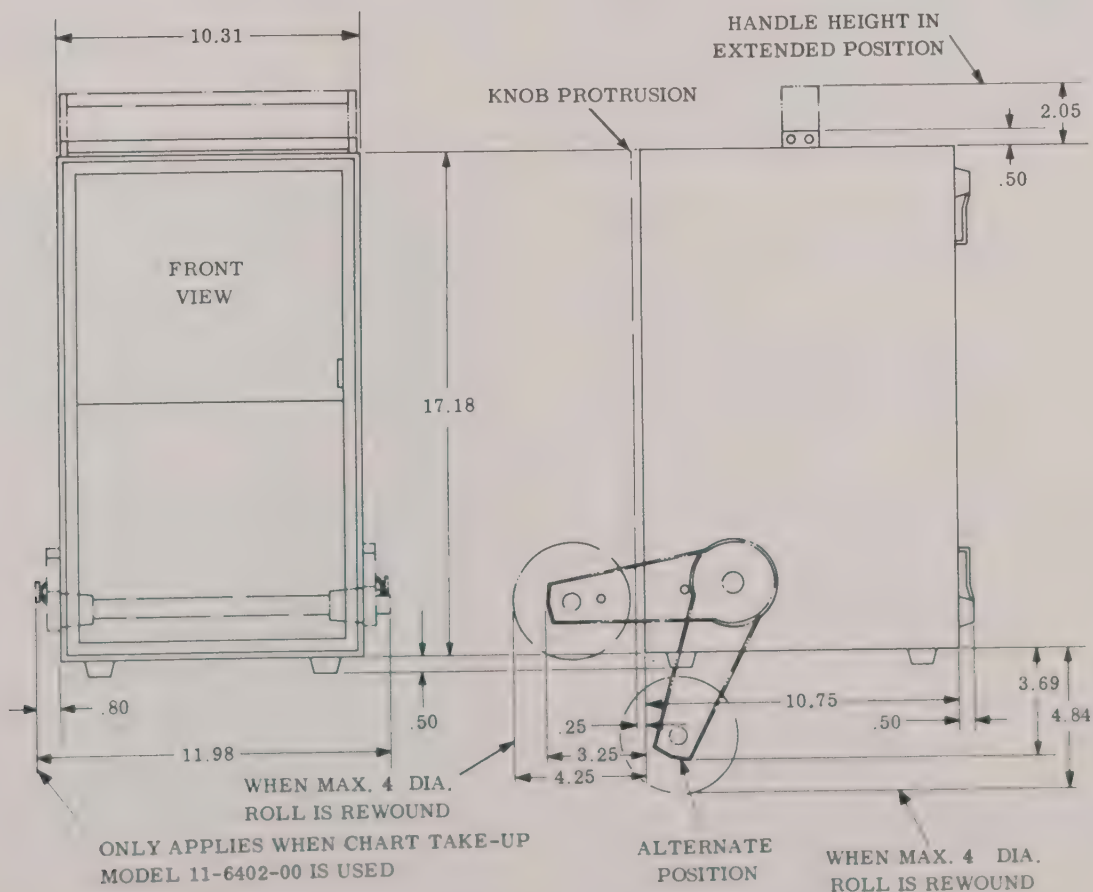


FIGURE 2-1 OUTLINE DIMENSIONS

SECTION III

SERVICING

3.1 GENERAL

This section describes and illustrates servicing procedures that are considered routine when the Mark 280 Recorder is in operation. These include loading or changing chart paper, and replenishing ink supply.

3.2 CHART PAPER

The following procedure describes and illustrates the correct method of loading or changing chart paper:

a. Removal

1. Turn MAIN POWER switch to the OFF position (Fig. 4-1).
2. Pull writing table to full open position (Fig. 3-1).
3. Hold supply roll and pull down on paper supply release lever (Fig. 3-1). Supply roll will drop free of table.

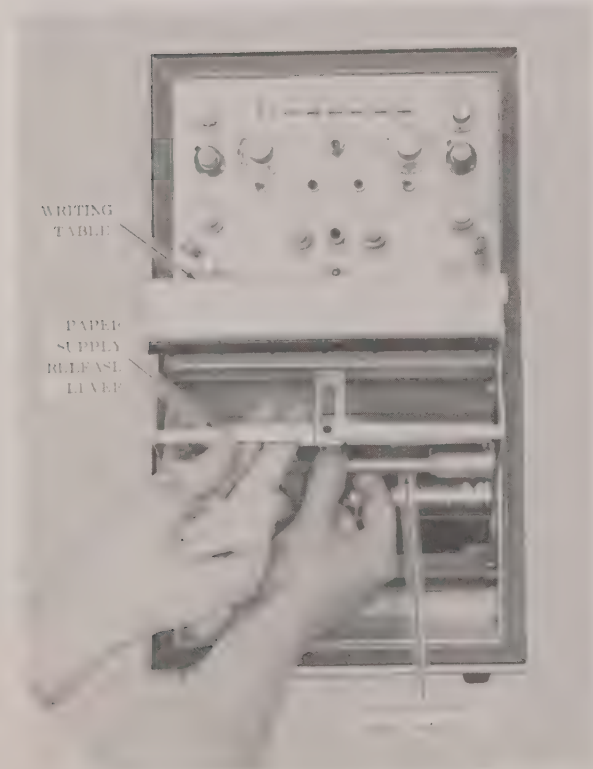


FIGURE 3-1 REMOVE PAPER SUPPLY ROLL

4. Unscrew flange from supply roll shaft in a counterclockwise direction (Fig. 3-2).
5. Discard used paper core.

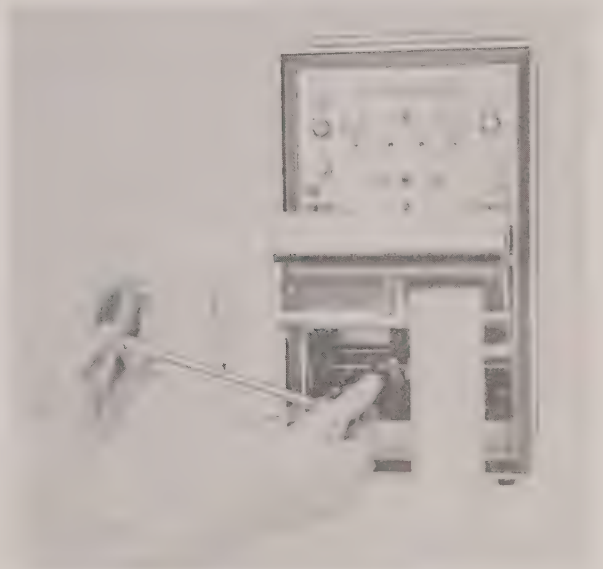


FIGURE 3-2 REMOVE PAPER SUPPLY ROLL
SHAFT FLANGE

b. Installation

1. Slide new paper supply onto supply roll shaft.

NOTE: Pins on shaft must engage notches in paper core.

2. Install flange onto supply roll shaft so that flange is gently snug against paper core.
3. Insert paper supply roll into writing table assembly and push paper supply release lever upward to lock paper supply roll in place (Fig. 3-3).

NOTE: Be sure paper supply roll shaft flanges are against stops to insure alignment of shaft with holes in writing table assembly.

4. Feed paper over writing bar, down the writing table, and behind the pressure roll as shown in Figure 3-4.

CAUTION: CARE MUST BE TAKEN TO AVOID DAMAGING THE PENS WHEN LOADING CHART PAPER.

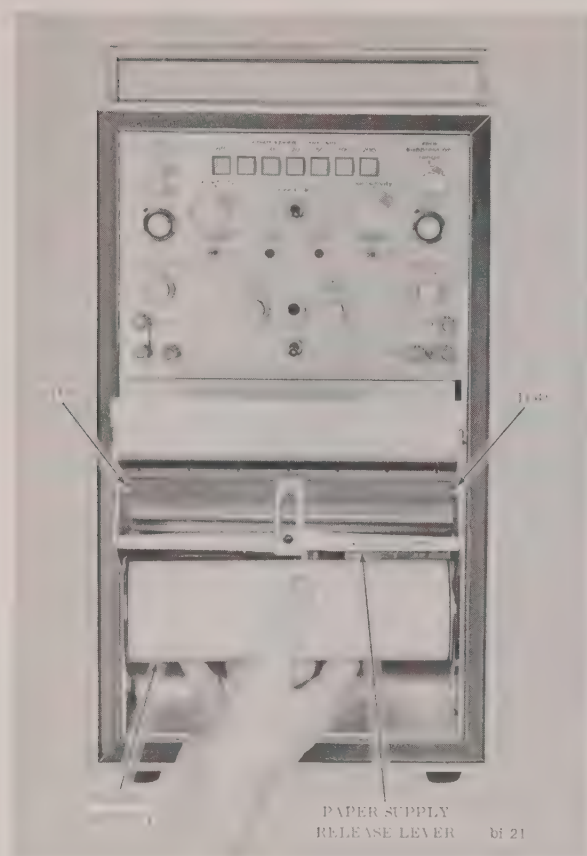


FIGURE 3-3. INSERT PAPER SUPPLY ROLL

5. Slowly close writing table assembly while pulling down gently on the chart paper. When friction brake resists rotation of supply roll, pull paper taut, center on writing table, and close writing table.

NOTE: This permits the chart paper to lie flat against the writing table and prevents formation of paper lock beneath pressure roll.

6. Turn on instrument and run through two feet of chart paper to stabilize chart.

3.3 INK SUPPLY

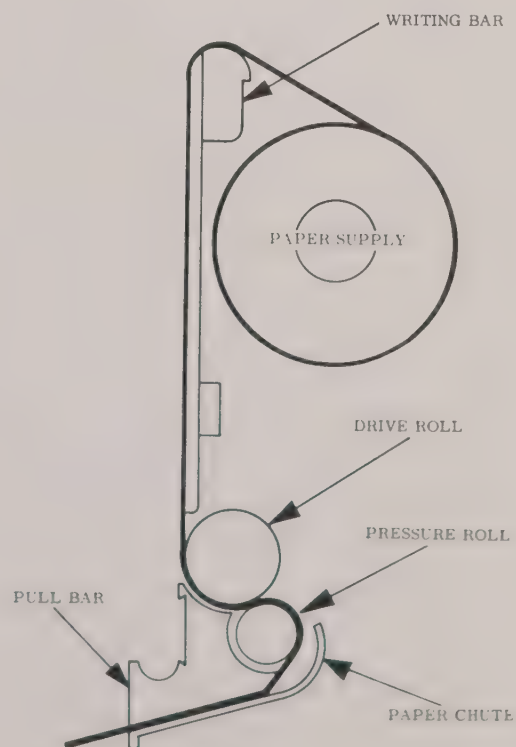
Normally a two ounce ink supply is sufficient for approximately 50 rolls of average recording. When it becomes necessary to add more ink, follow the procedure described below:

1. Turn MAIN POWER switch to OFF position.
2. Remove paper supply roll as described in Paragraph 3.2.a.
3. Unscrew cap from master cylinder (Fig. 3-5).

4. Push paper supply release lever upward to facilitate filling.
5. Remove cap from ink syringe and screw syringe tip clockwise into master cylinder (Fig. 3-6).
6. Inject ink into the cylinder until gage on master cylinder shows just under two ounces.

CAUTION: DO NOT OVERFILL PRESSURIZED INKING SYSTEM AS THIS WILL PREVENT INKING SYSTEM FROM RETURNING TO ZERO PSI WHEN UNIT IS TURNED OFF.

7. Unscrew syringe from cylinder and replace cap on master cylinder.
8. Pull paper release lever to the release position.
9. Install chart paper supply as described in Paragraph 3.2.b.
10. Turn main POWER switch to the ON position.



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FIGURE 3-4 PAPER LOADING DIAGRAM

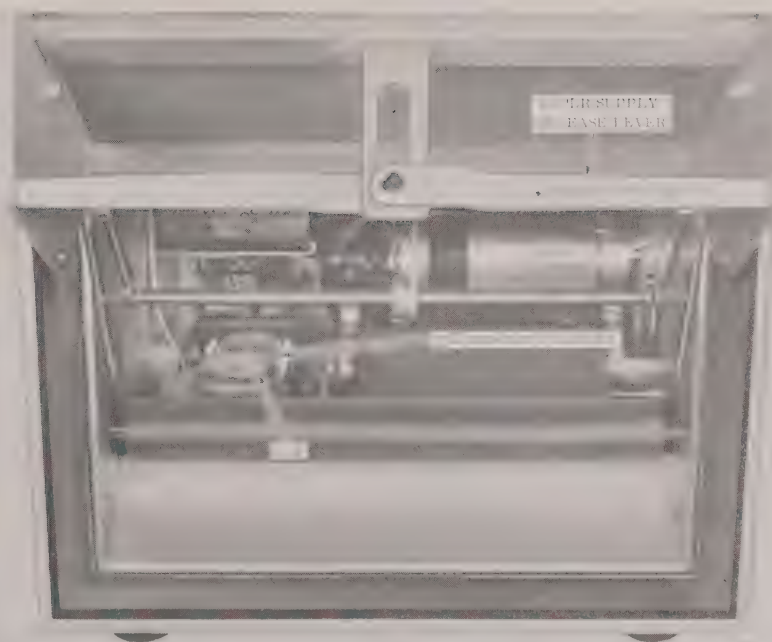


FIGURE 3-5 INK MASTER CYLINDER – REFERENCE VIEW

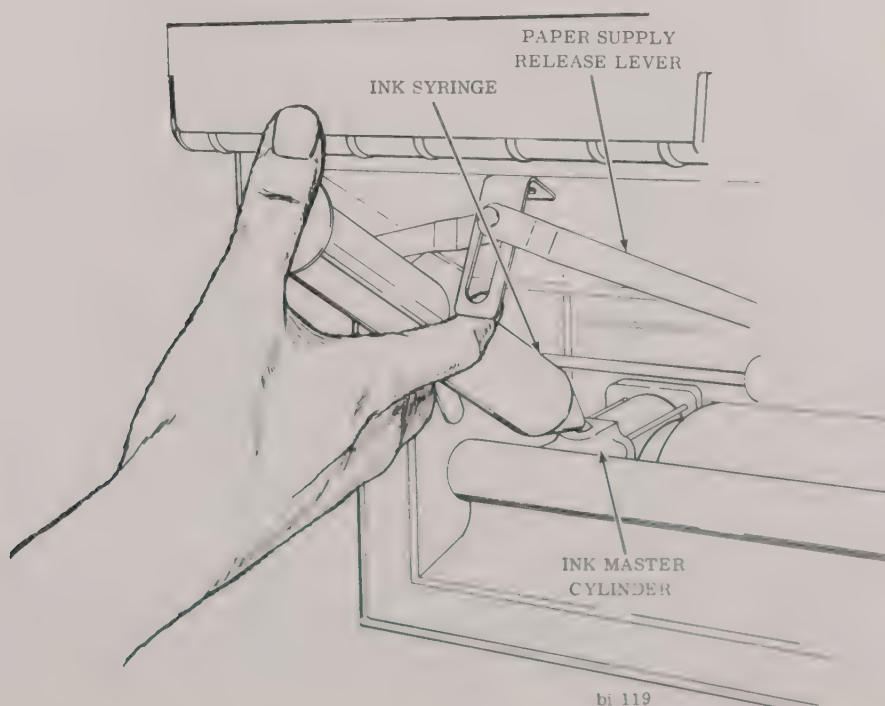


FIGURE 3-6 FILLING INK MASTER CYLINDER

SECTION IV

OPERATION

4.1 GENERAL

This section contains the information necessary for operation of the Mark 280 Recorder. This includes a description of the controls, procedures for preliminary operation, and instructions on the use of calibrated zero suppression.

4.2 CONTROL DESCRIPTION

a. Front Panel Controls

NOTE: The circled numbers in Figure 4-1 correspond with the items listed below.

Item No	Control	Description
1	Signal Input Terminals	1 and 2 INPUT and GROUND. These terminals are provided as convenient connections on the front of the unit.
2	Main POWER switch and Indicator	This switch provides power to the unit from an a-c power source. An indicator light immediately above the switch is energized when the switch is turned on.

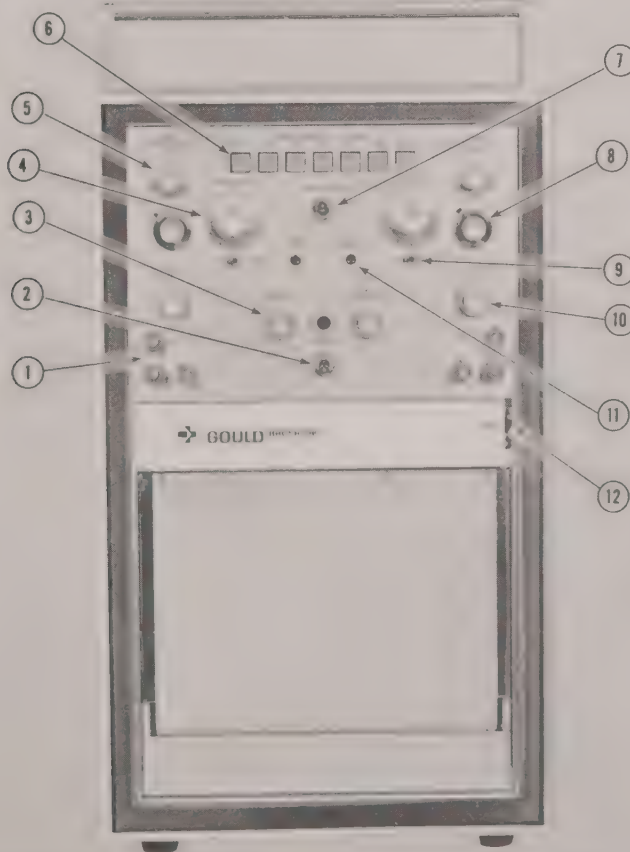


FIGURE 4-1 FRONT PANEL CONTROLS (15-6327-10 shown)

Item No	Control	Description
3	PEN POSITION Control	Positions pen to any point on chart for any attenuator setting. When locking knob is engaged, pen is locked in position.
4	SENSITIVITY (Attenuator) Control	An 8-position signal conditioning selector control. The attenuator is a voltage divider.
5	ZERO SUPPRESSION RANGE Control . . . (Models 15-6327-10,-14,-15,-16, only)	A 5-position control (+5, +1, OFF, -1 and -10) for selection of maximum voltage to be suppressed.
6	CHART SPEED Switch	A 7-position selector switch which operates as follows: OFF button stops chart drive operation and turns off power to pens. CHART SPEED MM/SEC buttons--one for each speed marked 5, 10, 20, 50, 100 and 200.
7	SPEED $\div$ 100 switch	When this 2-position switch is in the up position, chart speeds are divided by 100 and become .05, 0.1, 0.2, 0.5, 1 and 2 mm/sec.
8	ZERO SUPPRESSION VERNIER Control (Models 15-6327-10,-14,-15,-16, only)	This control permits fine suppression adjustments within the range indicated on the ZERO SUPPRESSION RANGE control.
9	X1/X100 Switch	In the times 1 position (X1) the sensitivity range is exactly as the SENSITIVITY control and ZERO SUPPRESSION RANGE control indicates. In the times 100 position (X100) the sensitivity range becomes .05, 0.1, 0.2, 0.5, 1, 2, 5, 10 volts/line, and the zero suppression range becomes +1000, +100, OFF, -100 and -1000 volts.
CAUTION: WHEN USING ± 1000 VOLTS ZERO SUPPRESSION DO NOT APPLY MORE THAN 500 VOLTS PEAK ACROSS INPUT TERMINALS.		
10	SENSITIVITY X1 Control	In the X1 (detent) position the sensitivity range is exactly as the dial indicates. When the control is removed from the detent position, it allows selection of a sensitivity within the ranges indicated on the dial.
11	MARK EVENT Button	Permits manual recording of an event. Normal activation is to the left.
12	PAPER Supply Indicator	This is a mechanical indicator that is linked to a sensor arm which notes roll diameter. A switch shuts the unit off when the paper supply is exhausted.

b. Rear Panel Control (Refer to Figure 4-2)

Timer Switch	Controls three-position event markers. INT — Switch is placed in this position when using an optional internal timer (Para. 6.11). EXT - Switch is placed in this position when using an external switch closure connected at rear of recorder. Switch is connected to terminals 1 and 2 for left marker and terminals 7 and 8 for right marker. Pen deflection is to the right. Event marker buttons operate with switch in either position.
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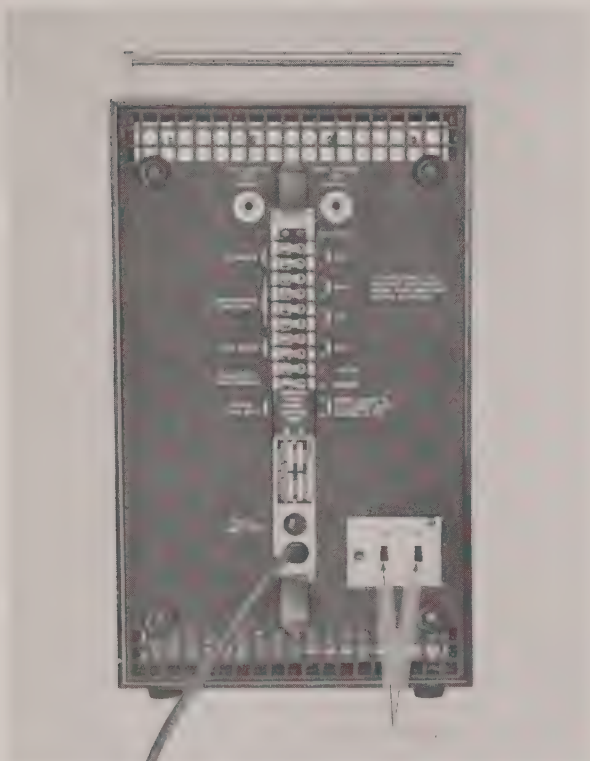


FIGURE 4-2 REAR PANEL CONTROLS

4.3 PRELIMINARY OPERATION

a. General

This paragraph describes the steps necessary to check out the Mark 280 Recorder on an operation to operation basis. If any of the checkout requirements listed herein cannot be made, refer to Section VII for complete calibration instructions.

b. Control Setting

1. Check that unit is connected to proper power source.
2. Check chart paper supply.
3. Turn both SENSITIVITY controls to the OFF position.
4. Press CHART SPEED OFF button.
5. Turn ZERO SUPPRESSION RANGE control to the OFF position (for applicable units).
6. Turn SENSITIVITY X1 control fully clockwise to X1 (detent) position.

7. Place the X1/X100 switch in the X1 position.

c. Operational Check

1. Apply a +0.0100 volt d-c $\pm 0.1\%$ signal to input terminals on front panel.

NOTE: Use terminals 1 and 2 (each channel) with terminal 1 connected to ground.

2. Turn POWER switch to on.
3. Select a slow chart speed.
4. Position pens to chart center with PEN POSITION controls.
5. Move SENSITIVITY from OFF position to 0.5 mv/div. Pens should deflect 20 lines to the left.
6. Turn SENSITIVITY control to OFF position.
7. Turn PEN POSITION control to determine that pens will travel full chart width.
8. Press MARK EVENT buttons. Event markers should deflect approximately one millimeter to the left.
9. Remove the +0.0100 volt d-c signal.

Unit is checked out and ready for operation.

4.4 USING CALIBRATED ZERO SUPPRESSION

a. General

Zero suppression permits the d-c component of a complex wave to be suppressed or bucked out, allowing the dynamic component to be amplified and recorded in greater detail. Calibrated zero suppression indicates the exact magnitude of that d-c voltage which has been suppressed. Location of the zero suppression system between the X1/X100 switch and the amplifier's attenuator provides calibrated zero suppression that is independent of both amplifier sensitivity and attenuator setting. This valuable feature permits amplifier sensitivity and attenuator settings to be changed at any time without resetting zero suppression controls. Zener regulated zero suppression voltage and temperature compensated components assure stable zero suppression readings.

The effective use of calibrated zero suppression can best be explained by describing two typical applications.

b. Application No. 1

To determine the character of a medium level complex signal which contains a positive static component, plus one or more dynamic components, proceed as follows:

1. Turn SENSITIVITY control to OFF position.
2. Place X1/X100 switch in the X1 position.
3. Turn ZERO SUPPRESSION VERNIER to full counterclockwise position.
4. Turn SENSITIVITY X1 control to the X1 (detent) position.
5. Operate chart at 5 mm/sec and use PEN POSITION control to set pen at chart center.
6. Turn SENSITIVITY control clockwise until pen approaches edge of chart. Note that the signal amplitude is less than 1 volt.
7. Set ZERO SUPPRESSION RANGE control at +1 volt position which will allow complete suppression of any static component up to 1 volt. Ten revolutions of the ZERO SUPPRESSION VERNIER now equal 1 volt; each revolution is equal to 100 millivolts and each dial division represents 2 millivolts.
8. Move dynamic component of signal to chart center by turning ZERO SUPPRESSION VERNIER clockwise.
9. Turn SENSITIVITY control clockwise as long as recorded trace increases in direct proportion to each increase in preamplifier sensitivity.
10. Read maximum peak-to-peak value of dynamic signal component from the recorder chart.
11. Use ZERO SUPPRESSION VERNIER to adjust dynamic signal component exactly to chart center.

NOTE: In situations where the SENSITIVITY control is at a high sensitivity position, the ability to set suppression at zero may be limited by the resolution of the ZERO SUPPRESSION VERNIER control.

12. From the ZERO SUPPRESSION VERNIER control, read to three places the average d-c component of complex signal.

13. Run a short length of chart at 100 millimeters per second or higher and determine the predominating frequencies which made up the dynamic component of this complex signal.

c. Application No. 2

To be certain that Calibrated Zero Suppression is thoroughly understood, this second example describes a medium level complex signal which has a large NEGATIVE static component. Since signal amplitude is greater than 2.5 volts, the input signal multiplier (X1/X100 switch) will be used in X100 position. Since static component is negative, the ZERO SUPPRESSION RANGE control is set at an appropriate negative voltage position.

1. Turn SENSITIVITY control to OFF position.
2. Place X1/X100 switch in the X100 position.
3. Turn ZERO SUPPRESSION VERNIER to full counterclockwise position.
4. Turn SENSITIVITY X1 control to the X1 (detent) position.
5. Operate chart at 5 mm/sec and use PEN POSITION control to position pen at chart center.
6. Turn SENSITIVITY control clockwise until pen approaches edge of chart. Note that signal amplitude is slightly less than 100 volts.
7. Set ZERO SUPPRESSION RANGE control to -1 volt position. Since input signal multiplier (X1/X100 switch) has been set in X100 position, a static component up to 100 volts may be completely suppressed. Ten revolutions of the ZERO SUPPRESSION VERNIER now equal -100 volts; each revolution is equal to -10 volts and each dial division represents -0.2 volts.
8. Turn ZERO SUPPRESSION VERNIER clockwise to bring dynamic component of signal to chart center.
9. Turn SENSITIVITY control clockwise as long as recorded trace increases directly in proportion to each increase in preamplifier sensitivity.
10. Read maximum peak-to-peak value of dynamic signal component from recorder chart.

11. Use ZERO SUPPRESSION VERNIER to bring dynamic signal component exactly to chart center.

NOTE: In situations where the SENSITIVITY control is at a high sensitivity position the ability to set suppression at zero may be limited by the resolution of the ZERO SUPPRESSION VERNIER control.

12. The average d-c component of complex signal, to three places, is read from ZERO SUPPRESSION VERNIER control.
13. Run a short length of chart at 100 millimeters per second or higher and determine the predominating frequency which makes up the dynamic component of this complex signal.

SECTION V

THEORY OF OPERATION

5.1 GENERAL

The Mark 280 Recorder consists of two analog channels, their associated preamplifiers, penmotor drive amplifiers, and common a-c and d-c power supplies (Fig. 5-1). The input to each channel, thru the modulator-demodulator type amplifiers, is floating and guarded while both outputs are single-ended and grounded, terminating at the penmotor drive amplifiers. Attenuation of the signal is accomplished by the controls on the front panel, as is pen position.

The penmotor drive amplifier is a complete servo-type system utilizing a Metrisite transducer in the penmotor to develop position and electronically derived velocity and acceleration signals. These signals are summed with an input signal in a d-c error amplifier that supplies power for driving the oscillographic penmotor.

The penmotors connect electrical signals to the mechanical pen which records thru a balanced hydrostatic ink system on chart paper.

5.2 DETAILED DESCRIPTION

a. X1/X100 Switch and Attenuator

Input signals are fed thru the X1/X100 switch which, in conjunction with the 8-position attenuator, provides 16 steps of attenuation.

b. Zero Suppression (on applicable units)

A floating d-c source, regulated by zener diode CR-706 and temperature compensated by diodes CR-701 thru CR-705, supplies the voltage for suppressing d-c components of input signals. The size of the inserted signal is controlled by ZERO SUPPRESSION RANGE (S-1) and VERNIER (R-17) front panel controls.

c. Chopper Modulator

Signals are modulated by a plug-in mechanical chopper G-1 and transformer T-1 at a rate of 400 Hz. The primary and secondary electrostatic shields on T-1 provide inphase rejection.

d. 400 Hz Generator

A 400 Hz square wave signal is generated by the multivibrator circuit Q-601 and Q-602 and fed to the chopper thru T-602. Part of the square wave voltage is also fed to the phase shifting network L-601 and C-605 and then to the demodulator thru T-602. L-601 and C-605 convert the applied square wave to a sine wave to provide the proper switching voltage for the sampling type demodulator and also provide the proper phase relationship between chopper and demodulator switching times. The phase is varied by the multivibrator FREQUENCY ADJUST control R-603.

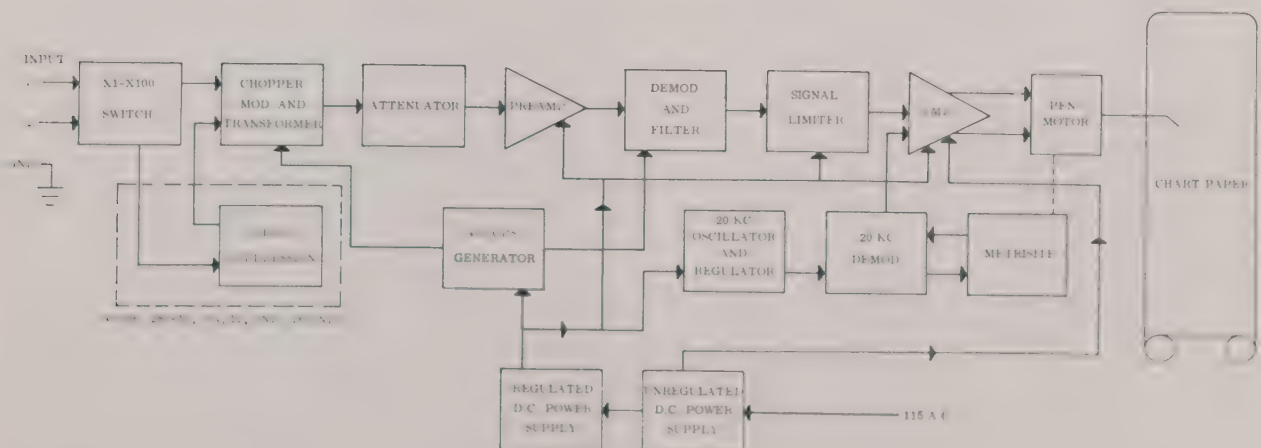


FIGURE 5-1 BLOCK DIAGRAM - MARK 280 RECORDER

e. Preamplifier

Transistors Q-201, Q-202 and Q-203 are a direct coupled triplet through CR-201 and CR-202. DC feedback through R-210, R-209 and R-208 provides temperature stability. AC gain is determined by R-205, R-209 and R-208 and is adjusted by VERNIER GAIN R-3. Transistors Q-301, Q-302 and Q-303 are a direct coupled triplet thru CR-301 and CR-302. Temperature stability is provided by d-c feedback thru R-311, R-310 and R-307 while a-c gain is determined by R-308 and R-311 and adjusted by GAIN control R-4.

f. Demodulator

Transformer T-9 and transistors Q-602 and Q-603 comprise a synchronous full wave demodulator whose output is filtered by L-602, C-607 and C-608. Bias for Q-602 and Q-603 is furnished by R-608, R-609 and C-606.

g. Signal Limiter

The signal is applied to the limiter transistors Q-501 and Q-502 thru protective diodes CR-501 thru CR-506. Maximum output voltage is limited by supply voltages at wipers of potentiometers R-503 and R-504 which are supplied with regulated +5 and -5 volts respectively. Ico balance potentiometer allows for no current flow in the input when the input is shorted.

h. D.C. Amplifier

The input signal, velocity and acceleration, position feedback and d-c feedback thru R-114 are summed at Q-107 to produce an error signal. This is paraphase coupled to Q-108 providing two polarities of error signal which are amplified by Q-109, Q-113, Q-114 and Q-110, Q-115 and Q-116 respectively. Transistors Q-23, Q-24, Q-25 and Q-26 are in a bridge output configuration. These drive the oscillographic penmotor which changes the electrical output of the d-c error amplifier to the mechanical motion of the pen and Metrisite. Transistors Q-111 and Q-112 provide current source proportions of the amplifier and CR-104, CR-105, CR-106 and CR-107 provide bias proportions of the amplifier. Fuse F-1 prevents excessive current from being drawn in the output circuit. Potentiometer R-118, INT POS, permits adjustment of pen centering while R-126, EQL OVER, permits equalization of power gains of the two halves of the d-c error amplifier. Diodes CR-101 and CR-102 protect temperature compensation.

i. 20 KC Demodulator

The full wave synchronous transistors Q-103, Q-104, Q-105 and Q-106 demodulate the 20 Kc position feedback signal supplied by the Metrisite and deliver a d-c position feedback signal to the a-c amplifier and thru the SPAN control R-6 to the error amplifier.

j. A.C. Amplifier

The d-c position feedback signal is passed thru R-106 CRS DAMP (acceleration) control and associated wave shaping networks to transistor Q-101 whose load resistor is the DAMPING (velocity and acceleration) control R-5. Transistor Q-102 supplies the velocity and acceleration currents, controlled by a thermistor in the penmotor, thru C-105 to the d-c error amplifier.

k. Power Supply

1. **Unregulated d-c Power Supply** A step-down power transformer supplies a-c power to two full wave supplies. The filtered outputs of these supplies are approximately 35 volts each. The common point is connected to the chassis. The -35 volt output is supplied to the final stages of the amplifier and the regulated power supply while the +35 volt output is connected to the regulated power supply.
2. **Regulated Power Supply** Transistors Q-41, Q-404 and Q-405 and associated circuitry comprise a voltage regulator referenced by zener diode CR-401 and adjusted by R-406, SET 26 VOLT control, to provide regulated -26 volts. Zener diode CR-404 provides shunt regulation to -5 volts and zener diode CR-405 provides shunt regulation to +5 volts. Transistors Q-404 and Q-39, isolated by transistor Q-40, comprise an oscillator amplifier circuit whose frequency is adjusted by L-401, 20 KC FREQUENCY, and amplitude controlled by transistor Q-408. Transistors Q-406 and Q-407, referenced by zener diode CR-406, control transistor Q-408 which is protected by diode CR-407. Diode CR-409, temperature compensated by diode CR-408, samples the 20 KC output while R-415, 20 KC LEVEL, permits amplitude adjustment.

SECTION VI

MAINTENANCE

6.1 GENERAL

The construction of the Mark 280 Recorder makes ease of maintenance one of the special features. This section describes and illustrates removal, installation, and adjustment procedures that can normally be performed at the field maintenance level.

6.2 CASE

a. Removal

1. Turn main POWER switch to OFF position.
2. Remove power input cord from power source.
3. If chart takeup is attached, remove from unit as described in Paragraph 6.3.a.
4. Unscrew four rubber feet securing rear cover to recorder and remove. (Fig. 6-1).
5. Reinstall four rubber feet on back of recorder.
6. Release unit from case by turning lock mechanism counterclockwise several turns. (Fig. 6-2)

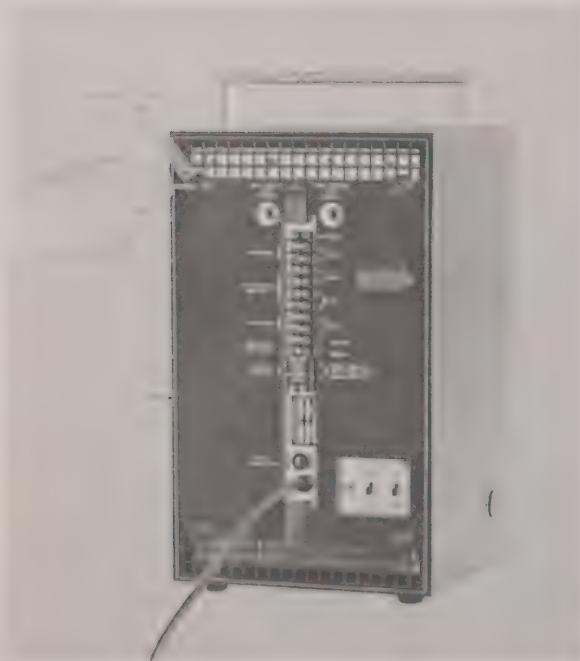


FIGURE 6-1 REMOVE REAR COVER

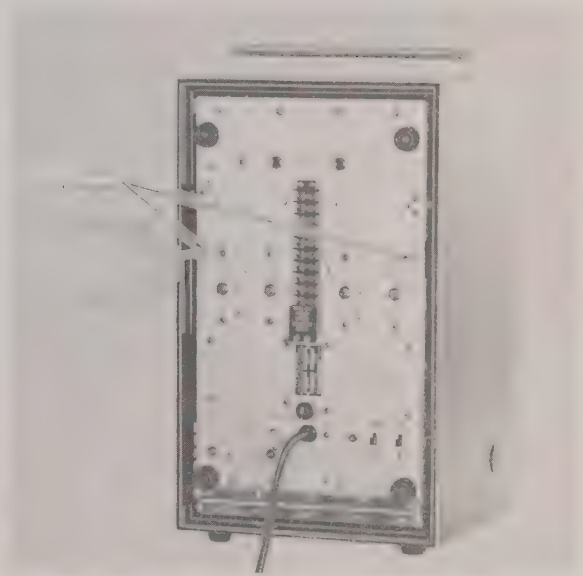


FIGURE 6-2 RELEASE UNIT FROM CASE

7. Carefully tilt recorder onto its back and gently slide case up and off of unit. (Fig. 6-3)
8. Place unit in upright position.
9. If necessary to open unit completely, raise control panel (Fig. 6-4) and loosen two knurled thumb screws that secure back of unit to side plates.

WARNING: TO PREVENT INJURY, BE CERTAIN THAT CONTROL PANEL IS FULLY RAISED AND HINGE IS NOT ACCIDENTLY FOLDED.

10. Gently lower back of unit to work bench.

CAUTION: DO NOT ALLOW BACK TO FALL FROM SIDE PLATES.

b. Installation

1. Raise back of unit to side plates, align two thumb screws, and secure back to side plates. (Fig. 6-4).
2. Lower control panel (Fig. 6-4) while guiding control panel between side plates.

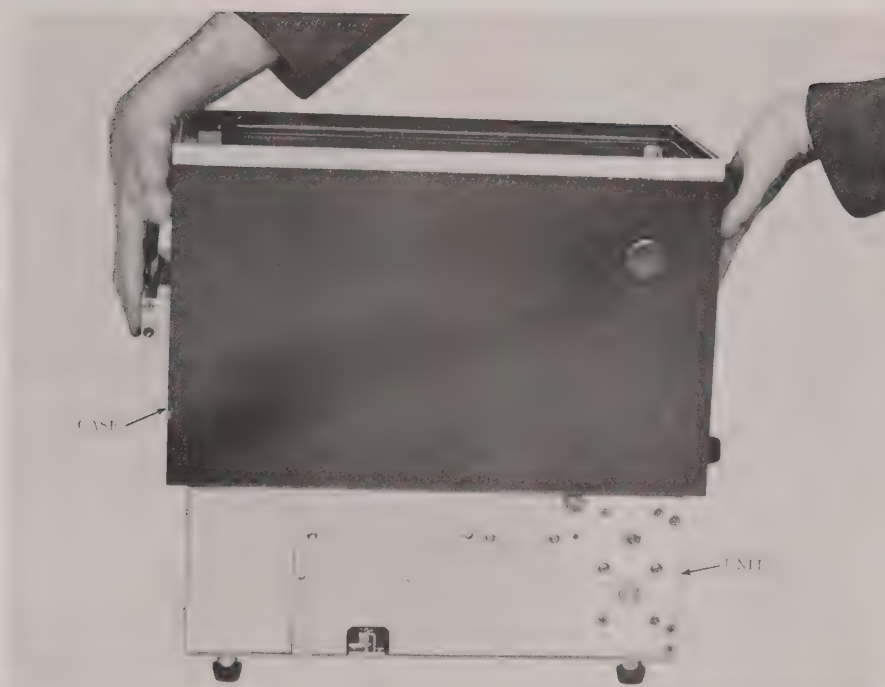


FIGURE 6-3 REMOVE CASE FROM UNIT

3. Place recorder onto four rubber feet attached to rear of recorder.
4. Slide case over recorder as shown in Figure 6-3.
5. Place unit in upright position using caution to keep unit in case.
6. Secure unit in case by turning the locking mechanism several turns in a clockwise direction (Fig. 6-2).
7. Remove four rubber feet from rear of recorder.
8. Install rear cover on unit by putting power input cord through cover and attaching cover to unit with four rubber feet (Fig. 6-1).

CAUTION: OBSERVE PROPER ALIGNMENT TO AVOID SHORTING OUTPUT TRANSISTORS.

9. Install power input cord into a suitable outlet.
10. Turn main POWER switch to the ON position.

6.3 CHART TAKEUP

1. Tear off chart paper.
2. Remove chart takeup shaft.
3. Remove two shoulder screws which secure chart takeup arms to side of unit and remove arms.

b. Installation

1. If chart takeup is being installed for the first time, remove plugs from side of case.
2. Position chart takeup arms onto side of unit making certain they are fully engaged.

NOTE: Right-hand arm has two drive pins that must be engaged with two holes in idler gear.

3. Secure in place with two shoulder screws.
4. Place takeup shaft in position.
5. Run through sufficient chart paper to attach onto takeup shaft.

6.4 ANALOG PENS

a. Removal

1. Turn off equipment.
2. Lift control panel and secure in raised position.
3. Slide individual ink valve for pen being removed to the OFF position.
4. Tear off chart paper.
5. Lift writing table far enough to release trapped ink from pen tips.
6. Slide paper forward along table surface until ink flow stops.
7. Tear off soiled paper and discard.
8. Replace writing table.
9. Gently pull down on pen tubing to disconnect tubing from manifold.
10. Use pen replacement wrench and loosen set screw securing pen to the drive arm shaft. (Fig. 6-5)

NOTE: Pen replacement wrench is larger of two wrenches provided with recorder (part number 1-120922-18).

NOTE: Do not loosen screw more than one-half turn or pen will not come out.

11. Carefully slide pen up and out of penmotor drive arm shaft.

b. Installation

1. Loosen set screw in pen hub.

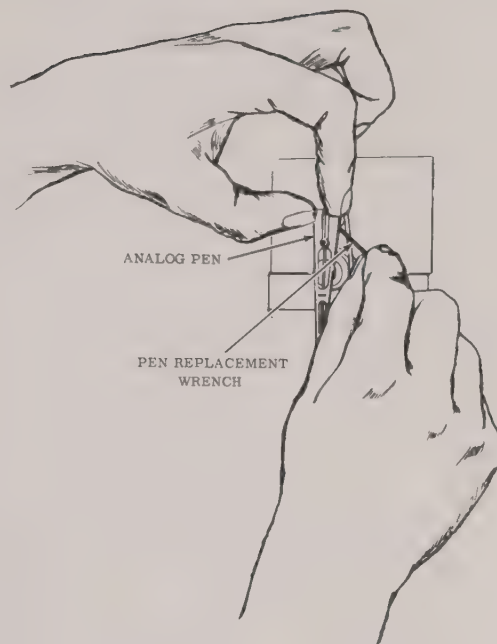


FIGURE 6-5 ANALOG PEN REPLACEMENT

NOTE: Do not loosen screw more than one-half turn or pen will not fit into drive arm shaft.

2. Carefully slide pen down into penmotor arm shaft.
3. Align screw in pen hub with access opening in drive arm shaft and tighten screw. Set screw should be sufficiently tight to create friction but not prevent rotation.

NOTE: This is not the final setting.

4. Insert ink tube from pen onto manifold, being careful to avoid kinking or creasing..

CAUTION: DO NOT USE TWEEZERS OR OTHER SHARP INSTRUMENTS WHEN INSTALLING TUBING.

5. Slide ink valve to the ON position.
6. Turn main POWER switch to the ON position.
7. Position pen in center of chart.
8. Start the chart paper moving by selecting a slow chart speed.

9. Lift pen slightly to allow ink to feed through to pen tip.
 10. Press recorder chart speed STOP button and turn power off.
 11. Gently grasp pen near hub and move pen across entire chart width (80 mm).
 12. If ink trace is not parallel to a horizontal time line, gently turn pen in penmotor drive arm until trace is parallel to time line.
 13. Use pen replacement wrench, tighten set screw securing pen in penmotor drive arm shaft and remove wrench.
 14. If pen tip is not on same time line as other pens, loosen two pan head adjustment screws and slide pen up or down until all pen tips are on same time line, and tighten screws.
 15. Check pen pressure and adjust if required (Para. 6.8 and 6.9).
 16. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grid M-600, Brush part number 669234) under pen tip.
 17. Move emery paper back and forth five or six times, parallel to chart time lines.
- CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.**
18. Remove emery paper, operate recorder at 5 mm/sec and check trace for dryness.
 19. If writing is not dry, proceed with normal pen lapping as described in Para. 6.10.
 20. Lower control panel.

6.5 EVENT MARKER PENS

NOTE: Refer to Figure 6-6 during removal and installation of event marker pens.

a. Removal

1. Turn off equipment.
2. Raise control panel.

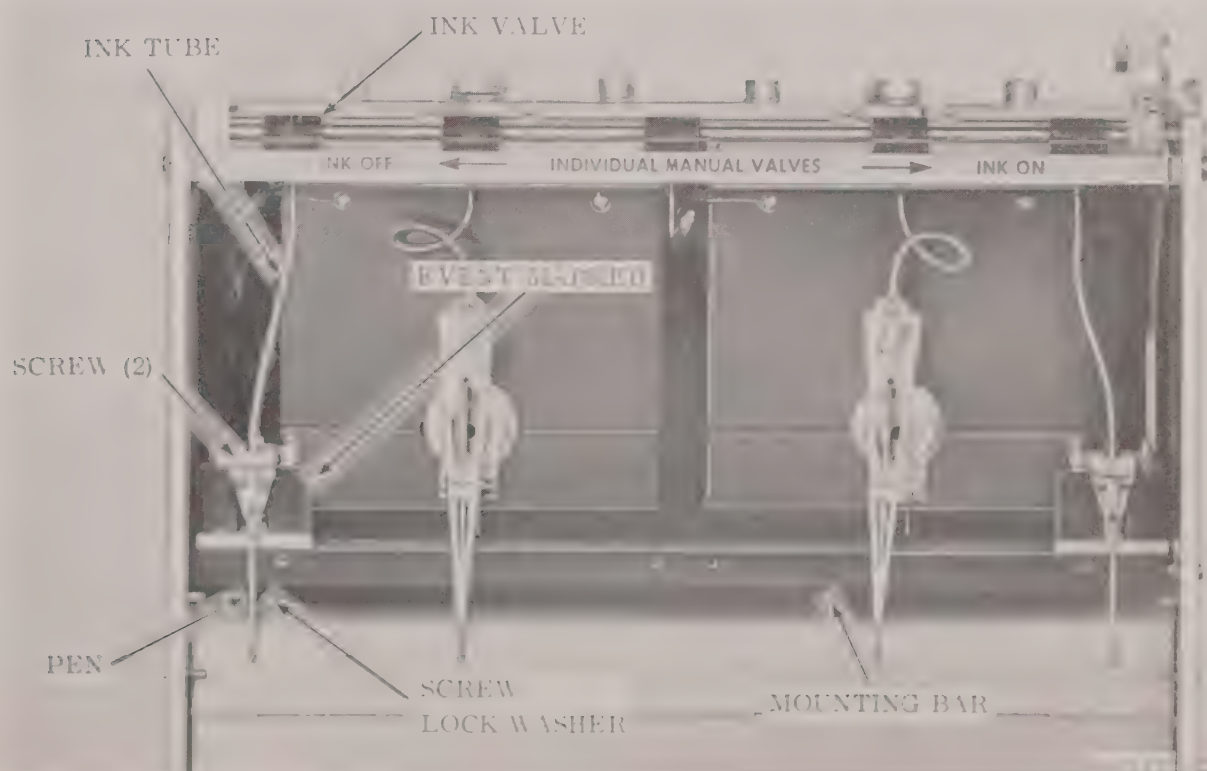


FIGURE 6-6 PEN AND EVENT MARKER REPLACEMENT

3. Slide individual ink valve for pen being removed to the OFF position.
4. Tear off chart paper.
5. Lift writing table far enough to release trapped ink from pen tips.
6. Slide paper forward along table surface until ink flow stops.
7. Tear off soiled paper and discard.
8. Replace writing table.
9. Gently pull pen tubing from manifold.
10. Loosen, but do not remove two screws securing pen to event marker unit and slide pen down from penholder support.

b. Installation

1. Slide event marker pen onto penholder support and adjust position so that tip is at same time position as other pens and centered in space between channels. Secure event marker pen in place by tightening the two screws.
2. Insert pen ink tube onto manifold, being careful to avoid kinking or creasing.

CAUTION: DO NOT USE TWEEZERS OR OTHER SHARP INSTRUMENTS WHEN INSTALLING TUBING.

3. Slide ink valve to the ON position.
4. Connect recorder to proper a-c power source and turn on recorder POWER.
5. Operate recorder at 5 mm/sec.
6. Lift pen slightly to allow ink to feed through pen tip.
7. Check pen pressure and adjust if required (Para. 6.8 and 6.9).
8. New pen must be lapped before proceeding. Carefully raise pen tip just enough to slide a small strip of emery paper (3M wet or dry Tri-m-ite paper, Grit M-600, Brush part number 669234) under pen tip.
9. Move emery paper up and down five or six times, parallel to division lines.

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

10. Remove emery paper, operate recorder at 5 mm/sec and check trace for dryness.
11. If writing is not dry, proceed with normal pen lapping as described in Para. 6.10.
12. Lower control panel.

6.6 EVENT MARKER

NOTE: Refer to Figure 6-6 during removal and installation of event marker.

a. Removal

1. Remove recorder from case (refer to Para. 6.2.a).
2. Raise control panel. (Fig. 6-4)
3. Slide individual ink valve for event marker being removed to the OFF position.
4. Tear off chart paper.
5. Lift writing table far enough to release trapped ink from pen tips.
6. Slide paper forward along table surface until ink flow stops.
7. Tear off soiled paper and discard.
8. Pull writing table to full open position and remove paper supply roll (Para. 3.2.a).
9. Gently pull pen tubing from manifold.
10. Disconnect event marker electrical lead at receptacle.
11. Remove screw and lock washer from underside of event marker mounting bar and lift off event marker.

b. Installation

1. Place event marker on mounting bar and install screw and lock washer from underside of bar.
2. Connect event marker electrical lead to receptacle as follows:

Red lead to A

Yellow lead to B

Green lead to C

White lead to D

3. Install chart paper supply roll (refer to Para. 3.2.b).
4. Insert ink tube from pen onto manifold, being careful to avoid kinking or creasing.

CAUTION: DO NOT USE TWEEZERS OR OTHER SHARP INSTRUMENTS WHEN INSTALLING TUBING.

5. Slide individual ink valve to ON position.
6. Lower control panel.
7. Install unit in case (refer to Para. 6.2.a).

6.7 REPLACING PENMOTOR BAND ASSEMBLY

The penmotor band assembly (part number 242999-910) should not be removed unless broken. Because the band tension is critical, a band replacement tool (part number 341409-915) must be used to replace band assembly.

NOTE: Penmotor need not be removed from recorder.

a. Removal

1. Remove analog pen (Para. 6.4).
2. Remove socket-head screw and band clamping (curved) washer that secures band assembly to drive arm (use wrench 1-120922-3).
3. Remove two socket-head screws and lock washers securing band assembly to drive arm bracket. Discard damaged band assembly. (use wrench 245218-5)
4. Position new band assembly around drive arm hub and install band clamping washer and socket-head screw. Do not tighten screw.

CAUTION: TO PREVENT DAMAGE TO THE NEW BAND ASSEMBLY, CHECK TO BE SURE DRIVE ARM AND BRACKET ARE FREE OF NICKS, DIRT, INK BEFORE INSTALLING NEW BAND ASSEMBLY.

NOTE: Check to be sure curved portion of washer is positioned to conform to the radius of the drive arm hub. Use care not to nick or scratch band assembly with tools or finger nails.

5. Align band assembly mounting holes with tapped holes in drive arm bracket and install two screws and lock washers. Do not tighten screws.
6. Inspect band for proper positioning around drive arm hub so that equal pressure is maintained on top and bottom of band assembly.
7. Install band tool on penmotor and thread knurled thumb screw into drive arm bracket.
8. Depress plunger and insert locking pin into two small holes of band assembly, making certain plunger is behind locking pin.
9. Tighten two screws in drive arm bracket, loosen one quarter- turn, move drive arm back and forth several times to center band assembly and tighten screws.
10. Move drive arm back and forth several times to center band assembly on drive arm and tighten socket-head screw securing band assembly to drive arm.

NOTE: Do not tighten more than 22 inch-ounces.

11. Depress plunger and remove locking pin.
12. Loosen knurled screw securing band tool to drive arm bracket and remove tool.
13. Apply glyptal cement (or equivalent) to heads of the three screws to prevent working out.
14. Install analog pen (Para. 6.4).

6.8 PEN PRESSURE MEASUREMENT

Analog or event marker pen pressure should be checked if the ink trace is excessively wide (bleeding), indicating low pen pressure or if pen gouges the chart paper, indicating excessive pen pressure.

NOTE: Wide trace may also indicate an improperly lapped pen. Refer to Paragraph 6.10 for pen lapping procedures.

The gram gage (part number 240601-910) is used to measure the pressure of the analog and event marker pens as follows:

1. Turn SENSITIVITY control to OFF position.
2. Turn on power to recorder.
3. Raise control panel.
4. Press the 5 mm/sec chart speed button.
5. Place gram gage hook under pen shaft as close as possible to tip and form a right angle to pen shaft with gage hook. (Fig. 6-7)
6. Pull pen from chart and take reading on gage the moment excessive ink starts to flow from pen.
7. Proper writing pressure for analog pens is 28 to 32 grams. Event marker pen pressure is 20 to 25 grams.

NOTE: If pen pressure reading is not within specification, refer to Paragraph 6.9 for pen pressure adjustment.

8. If pen pressure is correct for analog and event pens, lower control panel.

Recorder is ready for operation.

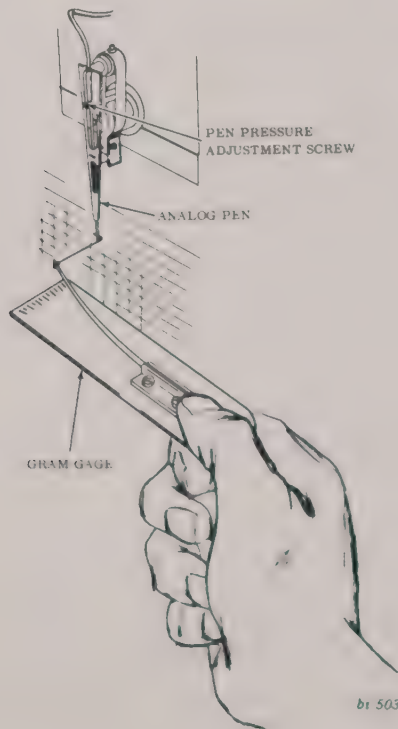


FIGURE 6-7 PEN PRESSURE MEASUREMENT

6.9 PEN PRESSURE ADJUSTMENT

When pens are replaced, pen pressure must be checked (Para. 6.8) and if required, adjust as follows:

1. Use pen pressure adjustment wrench (part number 1-120922-18) and turn adjusting screw (Fig. 6-8) clockwise to increase pressure or counterclockwise to decrease pressure.
2. Check pen pressure with gram gage (Para. 6.8) and continue adjustment until proper reading is obtained.
3. Lower control panel.

Recorder is ready for operation.

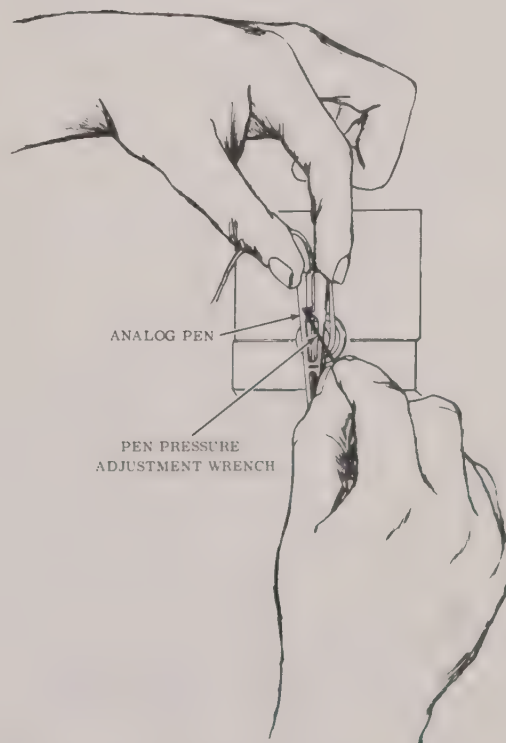


FIGURE 6-8 PEN PRESSURE ADJUSTMENT

6.10 PEN LAPPING

a. General

This paragraph describes and illustrates the proper procedures for lapping the analog and event pens. Intermittent or "wet" ink trace are indications that

pen pressure is incorrect or that pen requires lapping. Check for "wet" writing by operating the recorder at 5 mm/sec chart speed, with the SENSITIVITY control in OFF position. Check pen trace by wiping index finger, with moderate pressure, across trace approximately one inch below pen tip. If ink does not smear, the pen is properly lapped. If trace smears, check and adjust pen pressure (Para. 6.8 and 6.9). Repeat test, and if trace continues to smear, lapping is required.

b. Lapping Procedure

NOTE: Lapping of pens should only be done when required.

1. Turn recorder OFF.
2. Remove pen access cover (located directly below chart speed selector switch) by pulling on bottom of access cover.
3. Carefully raise pen tip just enough to slide a small strip of emery paper (4/0, Brush part number 141119) under pen tip.

CAUTION: DO NOT USE A COARSE OR VERY ABRASIVE TYPE OF EMERY PAPER. USE ONLY THE GRADE SPECIFIED.

4. Move emery paper back and forth under pen tip, parallel to chart time lines, for a total distance of approximately two inches. (Fig. 6-9)

CAUTION: MAKE SURE THAT EMERY PAPER IS HELD FLAT AGAINST THE CHART PAPER TO INSURE PROPER LAPPING OF PEN.

5. Remove emery paper, operate recorder at 5 mm/sec and check pen trace for dryness.
6. Repeat steps 1 thru 5 as required to obtain dry trace.

NOTE: If procedure is repeated more than three times, recheck pen pressure and repeat lapping. Strict adherence to above lapping procedures is imperative.

7. When dry trace is achieved, replace access cover.

6.11 LAPPING PROCEDURES FOR EXTENDED LIFE PEN, MODEL 11-2823-34

The Brush Model 11-2823-34 Extended Life Pen requires a different lapping procedure from that described in Para. 6.10. Install pen as described in Para. 6.4, but disregard lapping instructions referred to.

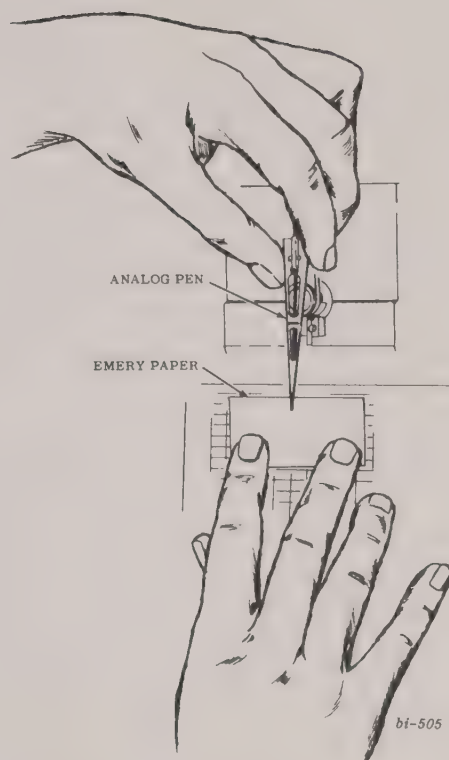


FIGURE 6-9 LAPPING PENS.

Lap Extended Life Pen as follows:

1. Raise control panel.
2. Shut off ink to all channels by sliding valves to OFF position.
3. Raise writing table and rewind chart paper so that no paper is left under pen tips. Be sure sufficient paper is on roll to energize interlock switch to permit recorder operation.
4. Now set pen pressure to 30 grams against writing bar (Para. 6.9).
5. Place coarser of two lapping papers supplied (Brush part number 668963) under pen tip. Set SENSITIVITY control to 50 MV/LINE and apply a 500 mv, 60 Hz signal.
6. Simultaneously move lapping paper back and forth under pen. Lap in this manner for 90 seconds.
7. Now repeat procedure using finer lapping paper (Brush part number 668965) for 90 seconds.

8. Return recorder to normal operating condition (thread chart paper over writing bar and slide ink valves on.)

NOTE: In most cases, one lapping will suffice, but occasionally two or three will be required to effect a proper seal.

9. If pen tip should become blocked during lapping operation, touch pen at top of bend (above tip) with a hot soldering iron for a few seconds with pen tip slightly raised off paper. This will generally start ink flowing and flush out abrasive.
10. Lower control panel.

6.12 OPTIONAL TIMER INSTALLATION

a. General

The One Second Timer 11-6101-20 and the One Minute Timer 11-6101-40 are optional equipment for the Mark 280 Recorder. When the One Second Timer is installed and the timer switch is in the internal position, the event marker pens will deflect to the left at one second intervals. With the One Minute Timer installed, the event marker pens will deflect to the left at one minute intervals.

The event marker buttons will over-ride the timer, or are used in the normal manner with the timer switch in the external position.

b. Installation

NOTE: Use the following installation instructions for either timer.

1. Remove case from unit and open unit for maintenance (Para. 6.2a).
2. Install timer assembly on mounting bar (Fig. 6-10) with two screws and lockwashers provided with timer.

NOTE: Install timer with motor leads (black) on top.

3. Connect four leads from timer assembly to terminal strip on mounting bar (Fig. 6-10) as follows:

Violet lead to terminal No. 1

White/green/yellow lead to terminal No. 2

Black leads to terminals No. 3 and 4.

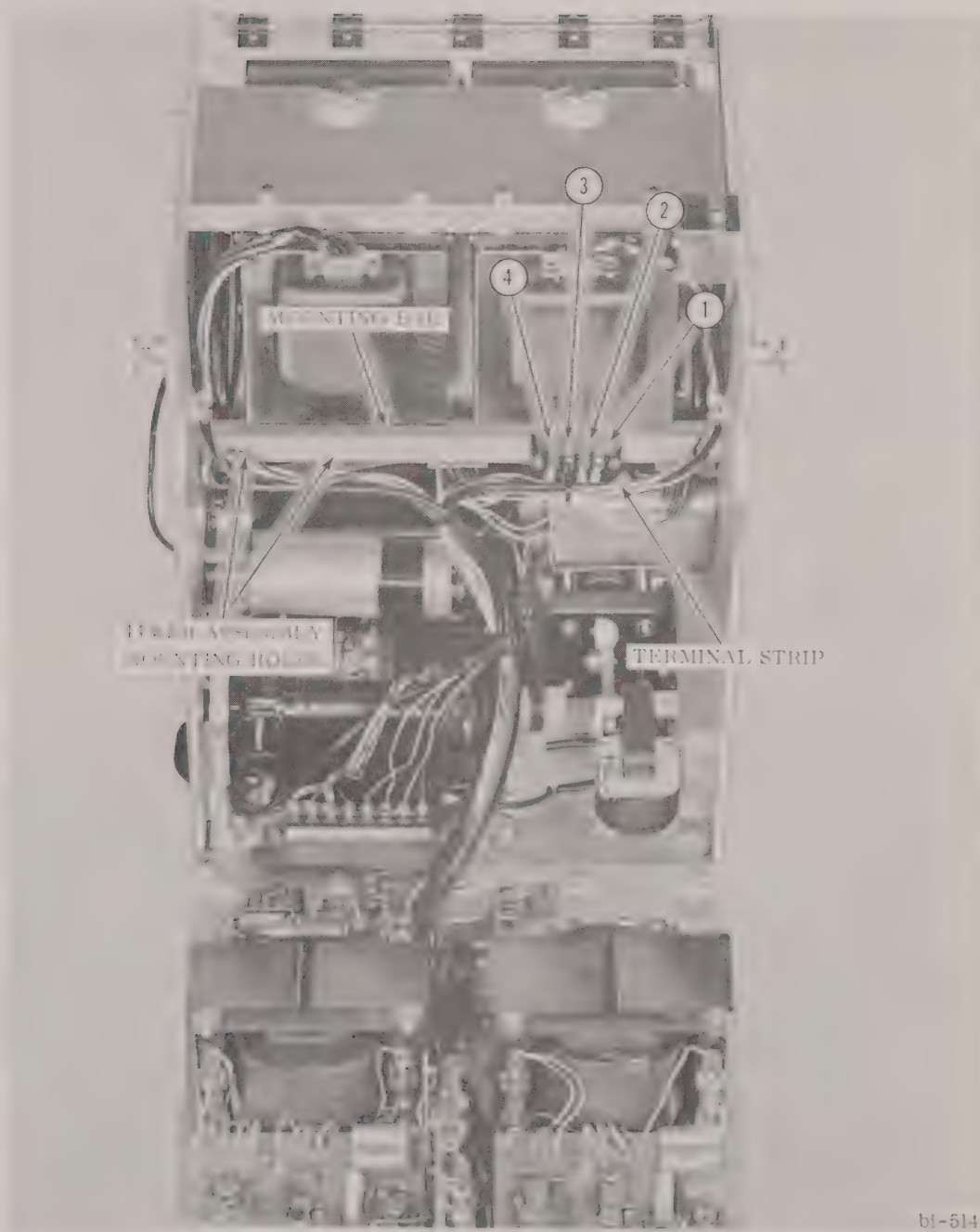


FIGURE 6-10 OPTIONAL TIMER ASSEMBLY MOUNTING LOCATION

SECTION VII

CALIBRATION

7.1 GENERAL

The Brush Mark 280 Recorder is calibrated at the factory to insure top efficiency. There may be times, because of parts repair or replacement, that it becomes necessary to adjust the calibration. The procedure is described below:

7.2 CALIBRATION PROCEDURE — All Models

a. Preliminary

1. Turn off main POWER switch.
2. Open unit to full maintenance position. (Refer to Paragraph 6.2)
3. Set the 25 volt adjustment control (A, Fig. 7-1) to its maximum counterclockwise position.
4. Set the I_{CO} BALANCE control (B, Fig. 7-1) to mid-range (7.5 turns).
5. Set the INTERNAL POSITION control (E, Fig. 7-1) to about mid-range (7.5 turns).
6. Set the CRS DAMP controls (G, Fig. 7-1) to about mid-range (7.5 turns).
7. Press chart speed OFF button and attach a voltmeter from either of the 1/8 amp fuses to point D (Fig. 7-1).
8. Turn on main POWER switch and set 26 volt adjustment control (A, Fig. 7-1) for -26 ± 0.5 volts.
9. Attach a voltmeter from point D to point F (Fig. 7-1) and adjust 20 KC level control (H, Fig. 7-1) for 7.0 ± 0.2 volts, RMS.
10. Adjust INTERNAL POSITION control so that pens are near chart center.
11. Attach a voltmeter from point D to point J (Fig. 7-1) and set EQUAL OVER control (C, Fig. 7-1) for approximately -13 volts d-c.
12. Operate chart speed switches and check for proper chart speed sequence.

b. I_{CO} Balance

1. Select slow chart speed.
2. While shorting and unshorting the drive amplifier inputs (Fig. 7-2) adjust the I_{CO} balance control (B, Fig. 7-1) until there is a minimum of pen movement.

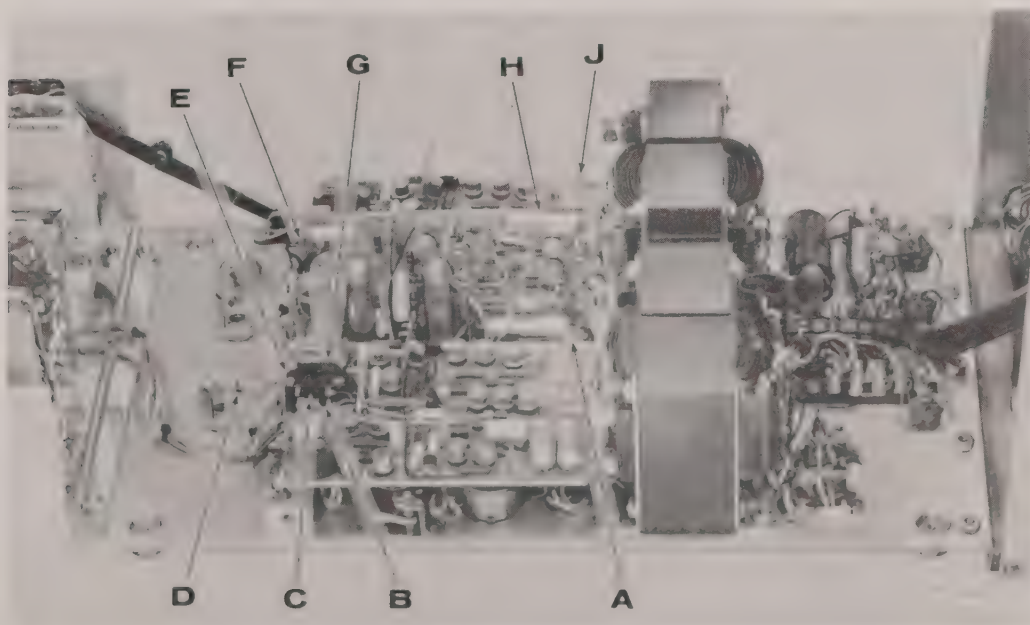


FIGURE 7-1 PRELIMINARY ADJUSTMENT POINTS AND POWER SUPPLY POINTS

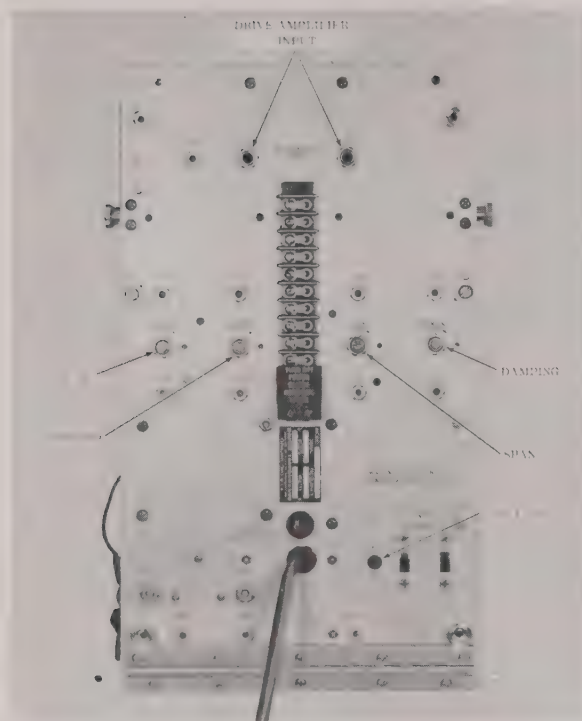


FIGURE 7-2 REAR PANEL CALIBRATION POINTS

c. Internal Position

Insert a shorted phone plug into the drive amplifier (Fig. 7-2) and adjust the INTERNAL POSITION control until pen is exactly at chart center.

d. Span and Drive Amplifier Linearity

NOTE: Refer to Figure 7-4 and rotate potentiometers (A & B) to full counterclockwise position.

1. From a 1 K or lower impedance source, apply $+2.5 \pm 0.005$ volts d-c to the input of the drive amplifier.
2. Adjust the span controls (Fig. 7-2) for a deflection of exactly 25 divisions.

e. Damping

NOTE: Apply all input signals through the preamplifier inputs.

1. Apply a 10 cycle sine wave amplitude of 10 divisions.
2. Switch frequency to 100 cycles and adjust the DAMPING control (Fig. 7-2) until the trace amplitude is exactly 10 divisions.
3. Apply a 5.5 cycle sine wave amplitude of 25 divisions.
4. Switch frequency to 55 cycles and adjust CRS DAMP control (G, Fig. 7-1) until 5.5 and 55 cycle amplitudes are equal.
5. Apply a one cycle sine wave amplitude of 10 divisions and increase frequency to 100 cycles. Peak to peak amplitude should be flat ± 0.5 division over entire range.
6. Repeat steps 1 through 4 until all conditions are met. Use DAMPING control only to adjust 100 cycle amplitude and CRS DAMP control only to adjust 55 cycle amplitude.

NOTE: Do not apply 55 cycle signal for more than 3 seconds out of any 15 seconds while making these adjustments.

7. Apply a full scale one cycle sine wave and increase frequency to 35 cycles, peak-to-peak. Amplitude should be flat ± 1 division over entire range.

f. Equal Overshoot

1. Adjust EQUAL OVER control (C, Fig. 7-1) until negative and positive overshoot patterns of a 10 div. square wave are similar.
2. A correct equal overshoot adjustment can be confirmed by applying a 10 divisions, 10 cycle sine wave signal followed by a 100 sine wave and noting the amount of zero shift on the 100 cycle trace. No zero shift indicates correct adjustment of equal overshoot.

g. Hysteresis

1. Center pen exactly at chart center.
2. Apply a +2.5 volt d-c signal to the drive amplifier input.
3. Remove the signal and check that pens return to zero ± 0.1 division.
4. Apply a -2.5 volt d-c signal and repeat test.

h. Phasing and Gain

1. Center pen exactly at chart center.
2. Apply $+10 \pm 0.01$ millivolts to both preamplifier input terminals.
3. Set ATTENUATOR at 0.5 millivolt/line. Adjust PHASING control (D, Fig. 7-3) for maximum peak pen deflection, on each channel.
4. Adjust preamplifier GAIN controls (B and E, Fig. 7-3) for exactly 20 divisions left pen deflection.

NOTE: Be sure the SENSITIVITY X1 control is in the X1 (detent) position.

i. Calibration Voltage

1. Set ATTENUATOR control at 50 millivolt/line and SENSITIVITY X1 control in X1 (detent) position.
2. Connect a preamp input to the "Cal 1 volt" jack (Fig. 7-2) and adjust the calibration control (C, Fig. 7-3) for 20 divisions left pen deflection ± 0.1 division.

NOTE: When installing the Calibration Cable 2-247187-1, route the cable assembly over the top of the unit from the cal source jack on the rear of the unit to the signal inputs on the front of the unit. This will eliminate the possibility of hum pickup from the motors if the cable is routed around the sides of the unit.

j. x1 Control

1. With "Cal" signal applied as in "i" above, turn the SENSITIVITY X1 control to its maximum counterclockwise position and see that the pen deflects to 5 to 8 divisions from zero.
2. Return control to x1 (detent) position.

k. Noise and Zero Shift

1. Completely close chassis.
2. Terminate all preamplifiers with a shielded 100 K resistor.
3. Check for noise and zero shift in all attenuator position.

NOTE: Zero shift shall not exceed 0.1 division and noise shall not exceed 0.2 division peak-to-peak.

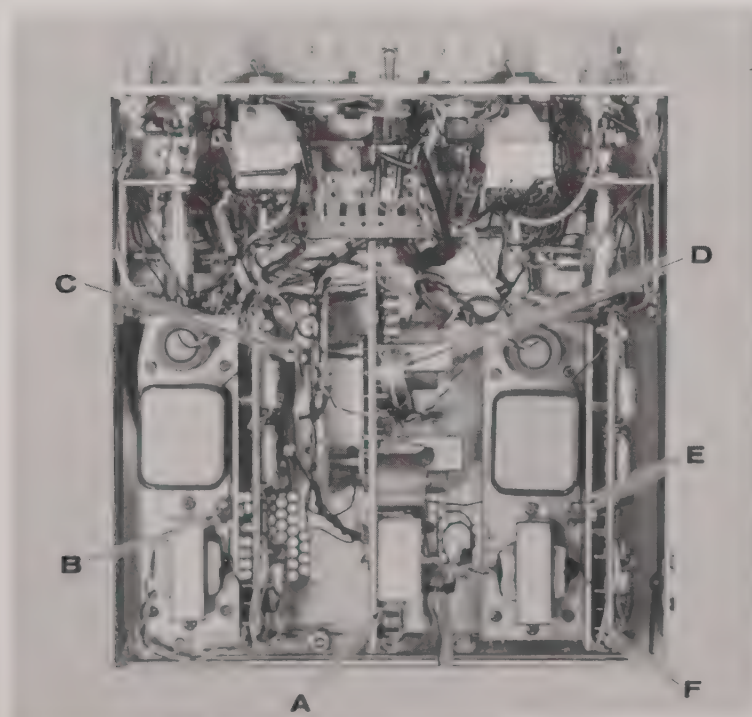


FIGURE 7-3 CALIBRATION TEST POINTS

I. Linearity

1. Set preamplifier gain at 0.5 millivolt/line.
2. Supply, from a stable d-c source, the voltages listed below.
3. Check for indicated pen deflection.

Voltage ± 0.063 MV	Pen Deflection Divisions ± 0.2 Division
+12.5 mv	Left 25
+10.0 mv	Left 20
+ 7.5 mv	Left 15
+ 5.0 mv	Left 10
+ 2.5 mv	Left 5
0	0
- 2.5 mv	Right 5
- 5.0 mv	Right 10
- 7.5 mv	Right 15
-10.0 mv	Right 20
-12.5 mv	Right 25

m. Attenuator

Test accuracy as indicated on following table:

NOTE: Attenuator settings from 20 millivolt/line to 0.5 millivolt/line need to be checked only for faulty switch operation or wiring since these attenuator resistors are used in previously checked position.

D.C. Signal	Attenuator Setting	Pen Deflection (Division)
+2.5 V	Off	Set at Zero
+2.5 V ± 2.5 mv	100 mv/line x1	Left 25 ± 0.25
+1.25 V ± 1.25 mv	50 mv/line x1	Left 25 ± 0.25
+ 0.5 V ± 0.5 mv	20 mv/line x1	Left 25 ± 0.25
+ 0.25 V ± 0.25 mv	10 mv/line x1	Left 25 ± 0.25
+ 0.125 V ± 0.125 mv	5 mv/line x1	Left 25 ± 0.25
+ 0.05 V ± 0.05 mv	2 mv/line x1	Left 25 ± 0.25
+ 0.025 V ± 0.025 mv	1 mv/line x1	Left 25 ± 0.25
+ 0.0125 V ± 0.0125 mv	0.5 mv/line x1	Left 25 ± 0.25
+ 1.25 V ± 1.25 mv	0.5 mv/line x100	Left 25 ± 0.25

n. Common Mode Rejection

1. Remove the grounding straps from the preamplifier input terminals.
2. Attach a 10 K resistor between terminals 1 and 2.
3. With ATTENUATOR control at 0.5 millivolt/line, apply 11 volts, RMS, 60 Hz ± 0.1 volt between terminals 1 and GND. Pen deflection shall not exceed 1.5 divisions peak-to-peak, 60 Hz.
4. Move x1/x100 switch to x100 position. Pen deflection shall not exceed 0.75 division.

o. Limiter Adjustment (Fig. 7-4)

1. Turn potentiometer (A) to full counterclockwise position.
2. Turn potentiometer (B) to full clockwise position.

NOTE: Potentiometer (A) controls left limiter and potentiometer (B) controls right limiter.

3. Apply an a-c triangle wave of sufficient amplitude to allow pens to travel approximately two divisions beyond full scale.

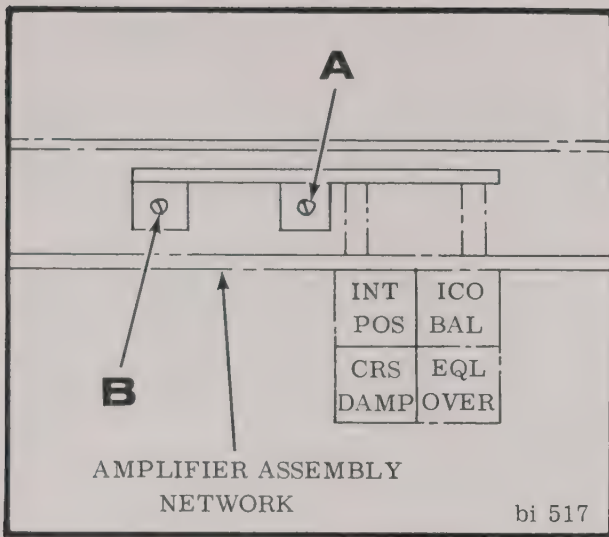


FIGURE 7-4 LIMITER ADJUSTMENT

NOTE: Full scale denotes full width of chart paper.

4. Adjust potentiometer (A) and (B) until pen travel is one division beyond full scale.
5. Apply a 0.1 to 1 Hz triangle signal, full scale, to the input. Select a chart speed and triangle rate so that sides of triangle are at a 90 degree angle. Check sides of triangle for straightness.

Unit is now calibrated. Remove all test equipment and close unit.

NOTE: The Zero Suppression circuit of Mark 280-10, -14, -15, and -16 Recorders is calibrated at the factory, but, because of parts repair or replacement may require adjustment. Refer to Paragraph 7.3.

7.3 ZERO SUPPRESSION CALIBRATION PROCEDURE (Fig. 7-5)

NOTE: LINE COMP is a factory adjustment and no attempt should be made to adjust this resistor.

a. 10 Volt Control

1. Carefully center pens on chart.
2. Set ATTENUATOR control on OFF.
3. Set RANGE control at +10 volts.
4. Set VERNIER control at 10.0.

5. Apply +10 volts ± 10 millivolts to the preamplifier inputs.
6. Set ATTENUATOR control at 100 millivolt/line and adjust the 10 volt control on top of the chassis for zero pen deflection.
7. Set ATTENUATOR control at 50 millivolt/line and recheck zero.
8. Set ATTENUATOR control on OFF and remove +10 volt input.

b. 1 Volt Control

1. Set RANGE control at +1 volt.
2. Set VERNIER control at 10.0.
3. Apply +1 volt ± 1 millivolt to the preamplifier inputs.
4. Set ATTENUATOR control at 50 millivolt/line and adjust the 1 volt control on top of the chassis for zero pen deflection.
5. Set ATTENUATOR control at 5 millivolt/line and recheck zero.

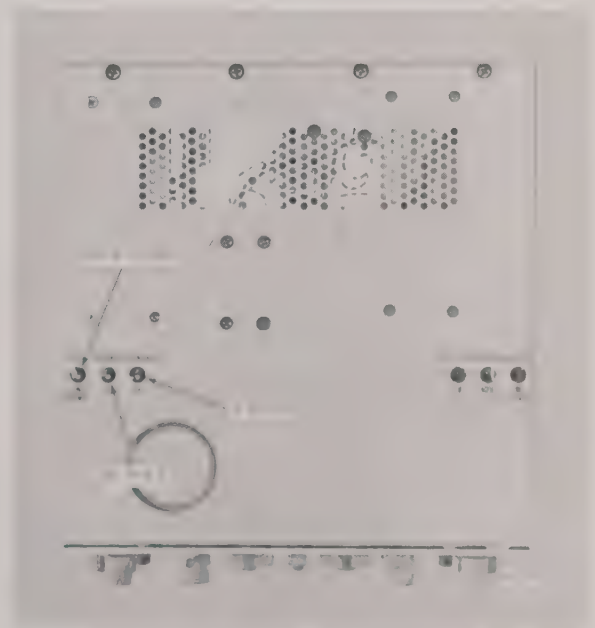


FIGURE 7-5 ZERO SUPPRESSION CALIBRATION

SECTION VIII

TROUBLESHOOTING

8.1 GENERAL

This section contains a troubleshooting table to assist personnel in isolating the cause of malfunctions which may occur in the Mark 280 Recorder. However, this section cannot cover all the possibilities of malfunction.

Contact your Brush Service Representative for assistance in restoring your Mark 280 Recorder to top operating condition.

CAUTION: THE INSTRUMENT MAY BE DAMAGED IF MAINTENANCE IS PERFORMED BY UNQUALIFIED PERSONNEL.

8.2 TROUBLESHOOTING TABLE

MALFUNCTION	CAUSE	REMEDY
1. Recorder inoperative	a. Power cable not connected	a. Connect power cable
	b. Blown fuse (F-5)	b. Replace fuse
	c. Main POWER switch not in ON position	c. Place switch in ON position.
	d. Interlock switch open indicating one of the following: 1) Paper supply exhausted 2) Writing table not in proper position 3) Faulty interlock switch	1) Load chart paper 2) Position writing table 3) replace interlock switch
2. No power to pens	Blown fuse (F-1,F-2,F-4)	Replace fuse
3. Chart paper drive does not operate	a. Main POWER switch not in ON position	a. Place switch in ON position
	b. Chart speed OFF button depressed	b. Select proper speed
	c. Lack of power at source	c. Connect to correct power source
	d. Defect in transmission; motor is running	d. Replace transmission
	e. Drive belt broken	e. Replace drive belt
	f. Defective drive motor	f. Replace motor
4. Chart paper speed is not as indicated by CHART SPEED buttons or does not change properly as CHART SPEED buttons are depressed.	a. Defective transmission	a. Replace transmission
	b. Defective contacts on chart speed switch	b. Replace switch

MALFUNCTION	CAUSE	REMEDY
5. Pen writes intermittently or not at all	a. Insufficient ink supply b. Pen clogged c. Individual ink valve in OFF position d. Ink tubing bent or kinked	a. Fill ink master cylinder b. Clean pen c. Slide ink valve to ON position d. Straighten or replace tubing
6. Individual pen trace extremely heavy	a. Improper pen pressure b. Pen tip not fully in contact with paper	a. Adjust pen pressure b. Lap pen
7. Pen tip gouges or tears paper	Improper pen pressure	Adjust pen pressure
8. Pen will not travel on timing line	Improper pen alignment	Align pen
9. Both pens do not move	a. Apply a signal to the drive amplifiers at rear of recorder. If neither pen moves, failure is in d-c power supply b. If signal is applied to drive amplifiers and pens move uncontrollably to one side of chart, failure is in 20 KC power supply c. If signal applied to drive amplifiers causes pens to move normally, failure is in 400 Hz supply	a. Notify your Brush Service Representative b. Notify your Brush Service Representative c. Notify your Brush Service Representative
10. One pen does not move or moves uncontrollably	a. Penmotor failure b. Apply a signal to the drive amplifiers at the rear of recorder. If pen moves normally, failure is in the pre-amplifier. If pen does not move, failure is in drive amplifier	a. Plug penmotor harness from operating channel into failed penmotor. If pen does not move, penmotor defective and must be replaced. If pen does move, proceed with step b, below b. Notify your Brush Service Representative

SECTION IX

PARTS IDENTIFICATION

9.1 GENERAL

This instrument has been accurately calibrated and adjusted before shipment from the factory and should give long, trouble-free service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Brush Service Engineer listed on the warranty card shipped with the recorder.

The following parts list and schematic diagrams are designed to assist in servicing and repairing the recorder.

NOTE: Check to be sure the schematic number and revision letter stamped on the rear of the instrument agree with the number and revision letter on the schematic contained in this section.

To assure prompt and satisfactory delivery of replacement parts, include the following with the purchase order:

1. Name, model number and serial number of the instrument.

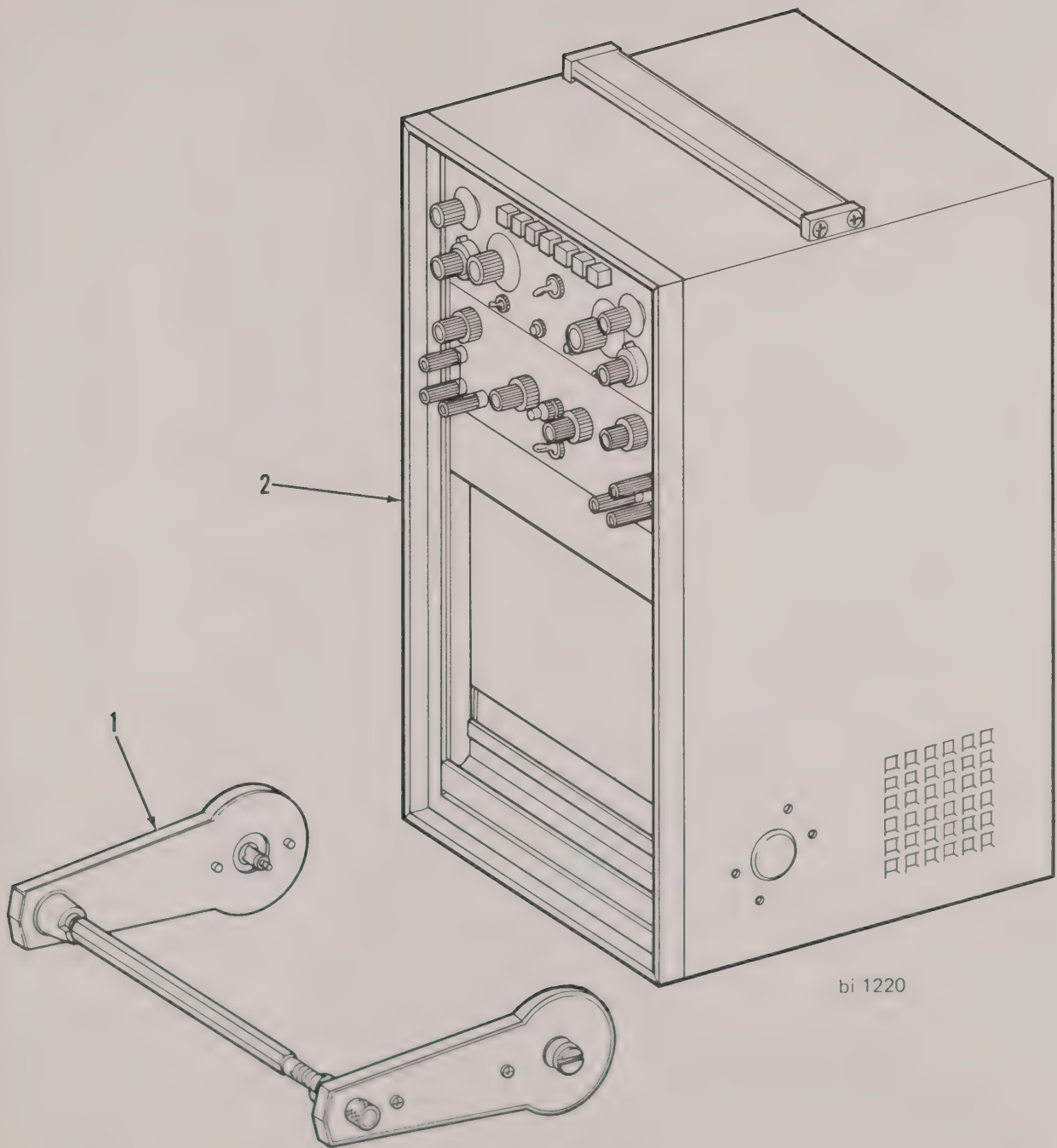
For Example: Brush 280 Recorder, Model 15-6327-10, Serial Number _____

2. Description of the part as listed in the parts list.
3. Brush part number

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

EXPLODED VIEW PARTS LIST
RECORDER SYSTEM, Mark 280 (All Models) — Figure 9-1

REF NO	DESCRIPTION	PART NUMBER
1	Chart Takeup Asm (optional)	11-6402-00 (see Figure 9-19)
2	Recorder Asm	All Models (see Figure 9-2)

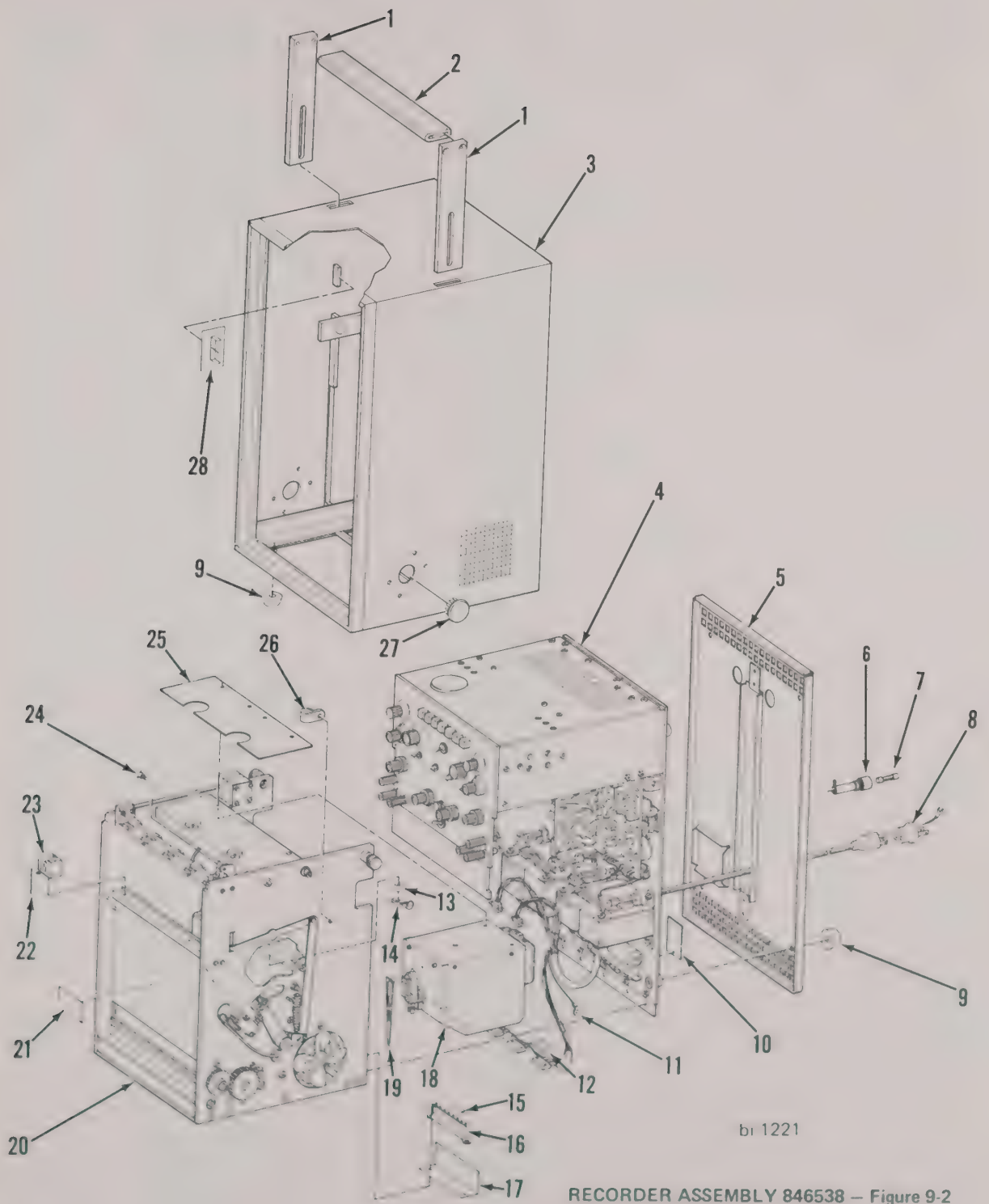


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RECORDER SYSTEM, MARK 280 (All Models) — Figure 9-1

EXPLODED VIEW PARTS LIST
RECORDER ASSEMBLY 846538 — Figure 9-2

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Slide, Handle	243824	
2	Handle	243885	
3	Case Asm	443662-910	
4	Electrical Asm (see Figure 9-3A & 9-3B)	846599	
5	Cover Asm, Back	846428	
6	Holder, Fuse	109669	
7	Fuse, Slo Blo	116198-13	F-5
7	Fuse, Slo Blo	116198-11 (used on Mark 280-06,-16)	F-5
7	Fuse, Slo Blo	116198-33 (used on Mark 280-04,-14)	F-5
8	Power Cable	126295-7	
9	Bumper	120903-221	
10	Nameplate	127215	
11	Lug, Soldering	11528-21	
12	Insulation, Paper	241960	
13	Spacer	3210-3	
14	Clamp, Cable	124804-2	
15	Diode, Semiconductor	243853	CR-27 thru CR-30
16	Board, Terminal	100184-6	
17	Insulator	246961	
18	Penmotor Asm	442900-915	
19	Pen Asm, Rect Ink	11-2823-31	
20	Recorder Subasm (see Figure 9-6A & 9-6B)	846431	
21	Label	466842-2	
22	Pen Asm, Event	RA-2821-20	
23	Event Marker Asm	341935-915 (RA-2103-90)	
24	Bolt, Shoulder	241838	
25	Shield	245096	
26	Clamp, Cable	124904-1	
27	Button, Plug	244090	
28	Pad, Handle	243996	



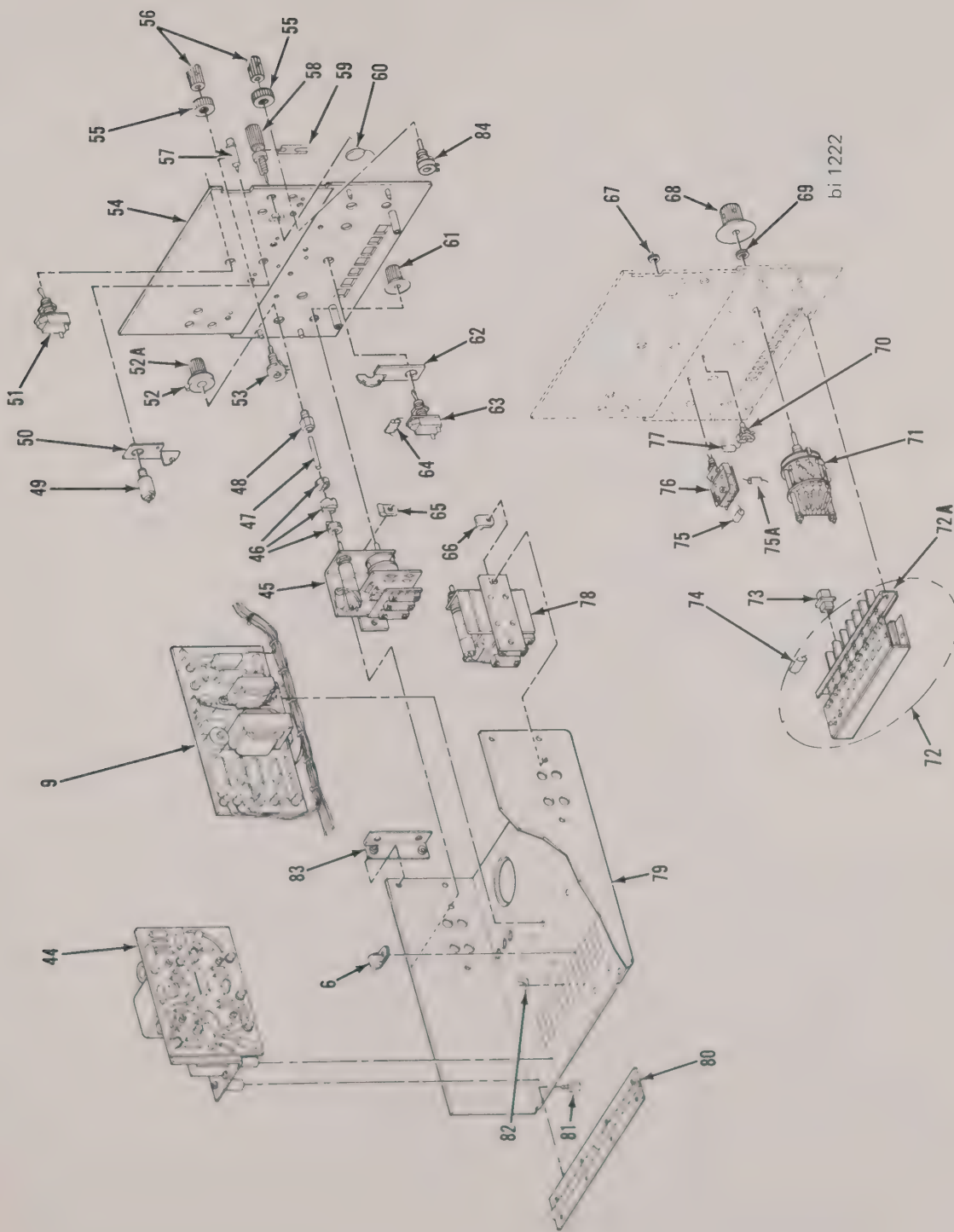
RECORDER ASSEMBLY 846538 — Figure 9-2

EXPLODED VIEW PARTS LIST
ELECTRICAL ASSEMBLY 846599 — Figure 9-3A & 9-3B

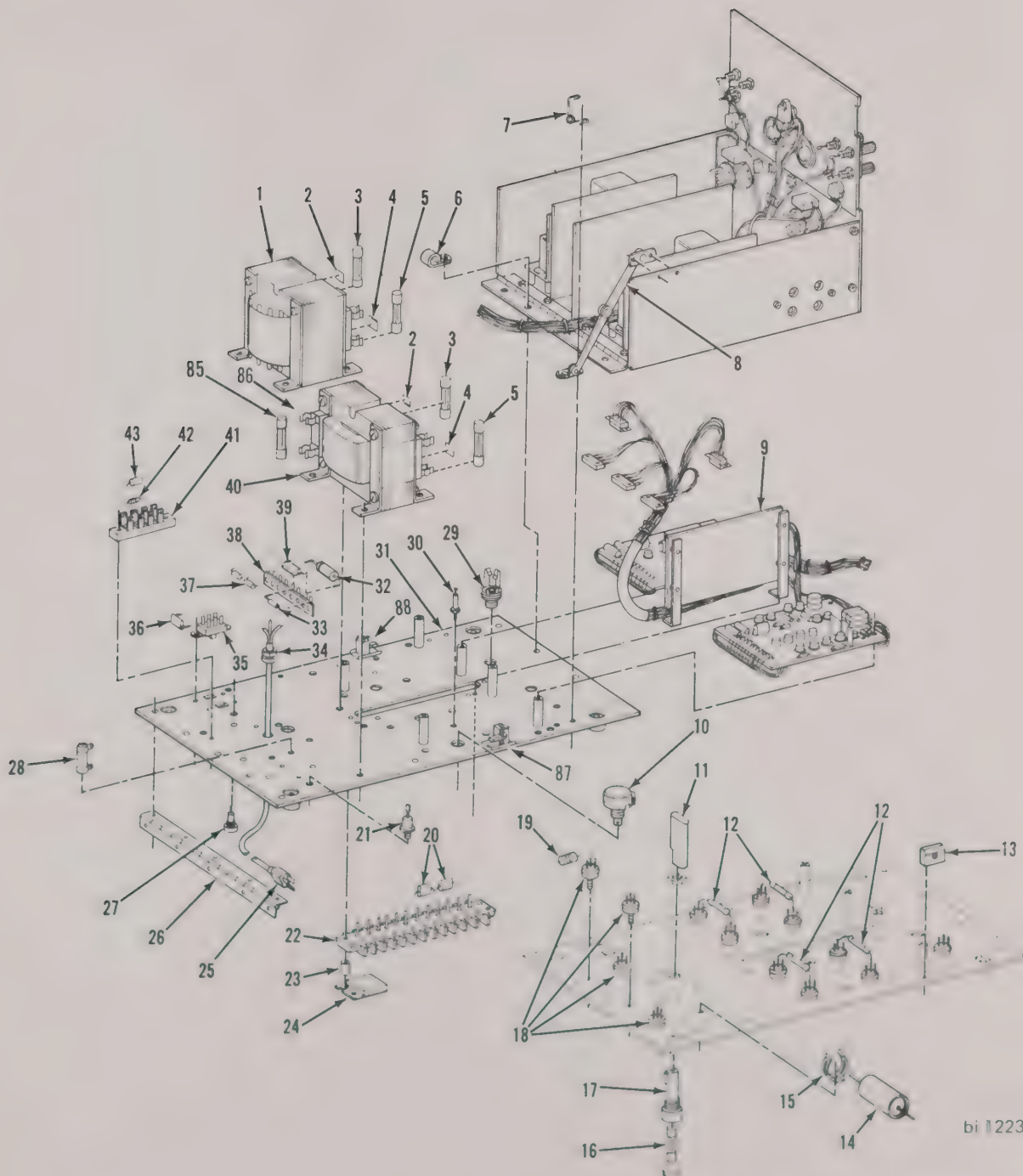
REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Transformer	344138	T-7
2	Decal	246727	
3	Fuse, Quick Disconnect	102625-2	F-2
4	Decal	246725	
5	Fuse, Quick Disconnect	102625-7	F-1
6	Clamp, Cable	124804-3	
7	Spring	243925	
8	Hinge Asm	665195	
9	Harness Asm (see Figure 9-4)	846583	
10	Resistor, Variable	240638	R-5,R-6
11	Insulation	0-108400-8	
12	Resistor	5-242300-1R5	R-7,R-8
13	Block	243523	
14	Capacitor	128020-507	C-52
15	Clamp, Retaining	234408-7	
16	Fuse, Slo Blo	116198-7	F-5
17	Holder, Fuse	109669	
18	Transistor	243077-4	Q-23 thru Q-26 Q-39 thru Q-43
19	Resistor	5-115559-331	R-19
20	Capacitor	10-241145-404	C-65,C-66
21	Semiconductor	242640	CR-1,CR-2
22	Board, Terminal	2-112429-12	TB-1
23	Spacer	130945	
24	Cover Asm, Terminal	645702	
25	Cable	126295-7	P-1
26	Hinge, Bottom	243489	
27	Jack, Tip	242011-2	J-6
28	Resistor	245490-401	R-13
29	Jack, Telephone	114814-7	J-1
30	Terminal, Insulated	1-123295-8	
31	Plate Asm	846464	
32	Capacitor	243006-356	C-62
33	Resistor	5-115557-150	R-10
34	Insulator, Strain	108572-11	
35	Switch, DPDT	244302	S-7,S-8
36	Capacitor	10-241145-104	C-60,C-64
37	Rectifier	130198-1	CR-24,CR-25
38	Board, Terminal	116858-8	
39	Capacitor	10-241145-204	C-49
40	Inductor	344139	L-8
41	Board, Terminal	242912-4	
42	Resistor	5-115557-472	R-20
43	Diode, Zener	242714	CR-26
44	Preamplifier Subasm	846474 (see Figure 9-13)	
45	Zero Suppression Asm	764147 (see Figure 9-16)	

EXPLODED VIEW PARTS LIST (continued)
ELECTRICAL ASSEMBLY 846599 — Figure 9-3A & 9-3B

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
46	Coupling	245912-2	
47	Shaft	232042	
48	Bushing	246382	
49	Holder, Lamp	241775-2	
50	Catch, Friction, Bottom	346366	
51	Switch, Toggle, SPST	234028	S-6
52	Dial	240937	
52A	Knob, Turns Counting	241147	
53	Resistor, Variable	246394-254	R-11,R-12
54	Panel Asm, Control	746549 (used on Mark 280-10,-14,-15,-16)	
54	Panel Asm, Control	746637 (used on Mark 280-01,-04,-05,-06)	
55	Nut, Self Locking	231182	
56	Knob	231183	
57	Lamp, Incandescent	1-241774-7	DS-1
58	Post, Binding	126395-13	
59	Jumper	127457	
60	Capacitor	240352-103	C-63
61	Knob	241147	
62	Catch, Friction, Top	346351	
63	Switch, Toggle, SPST	234028	S-4
64	Capacitor	10-241145-503	C-51
65	Clamp, Cable	124804-1	
66	Clamp, Cable	124804-3	
67	Nut, Knurled	240093	
68	Nob Asm	646451	
69	Nut, Knurled	246415	
70	Switch, Push	246422-1	S-9,S-10
71	Switch Asm	746663 (see Figure 9-17)	
72	Switch Asm	746358	S-1001
72	Switch Asm	764159 (used on Mark 280-04,-14)	S-1001
72A	Switch	446357	
73	Button, Push	246552-1	
74	Capacitor	10-241145-503	C-1001,C-1002,C-1003
75	Resistor	R1-246659-99002	R-1
75A	Resistor	R1-245853-10101	R-2
76	Switch Asm	231861-910	S-2
77	Capacitor	10-241145-104	C-55,C-54
78	Zero Suppression Asm	764145 (see Figure 9-18)	
79	Chassis Subasm	746486	
80	Hinge, Top	243490	
81	Spacer, Threaded	245074	
82	Solder Lug	11528	
83	Bracket Asm	647405	
84	Switch and Resistor Vari	246393-303	S-3,R-3
85	Fuse	125470-11	F-4
86	Fuse Holder	232877	
87	Latch, Case RH	243537-1	
88	Latch, Case LH	243537	

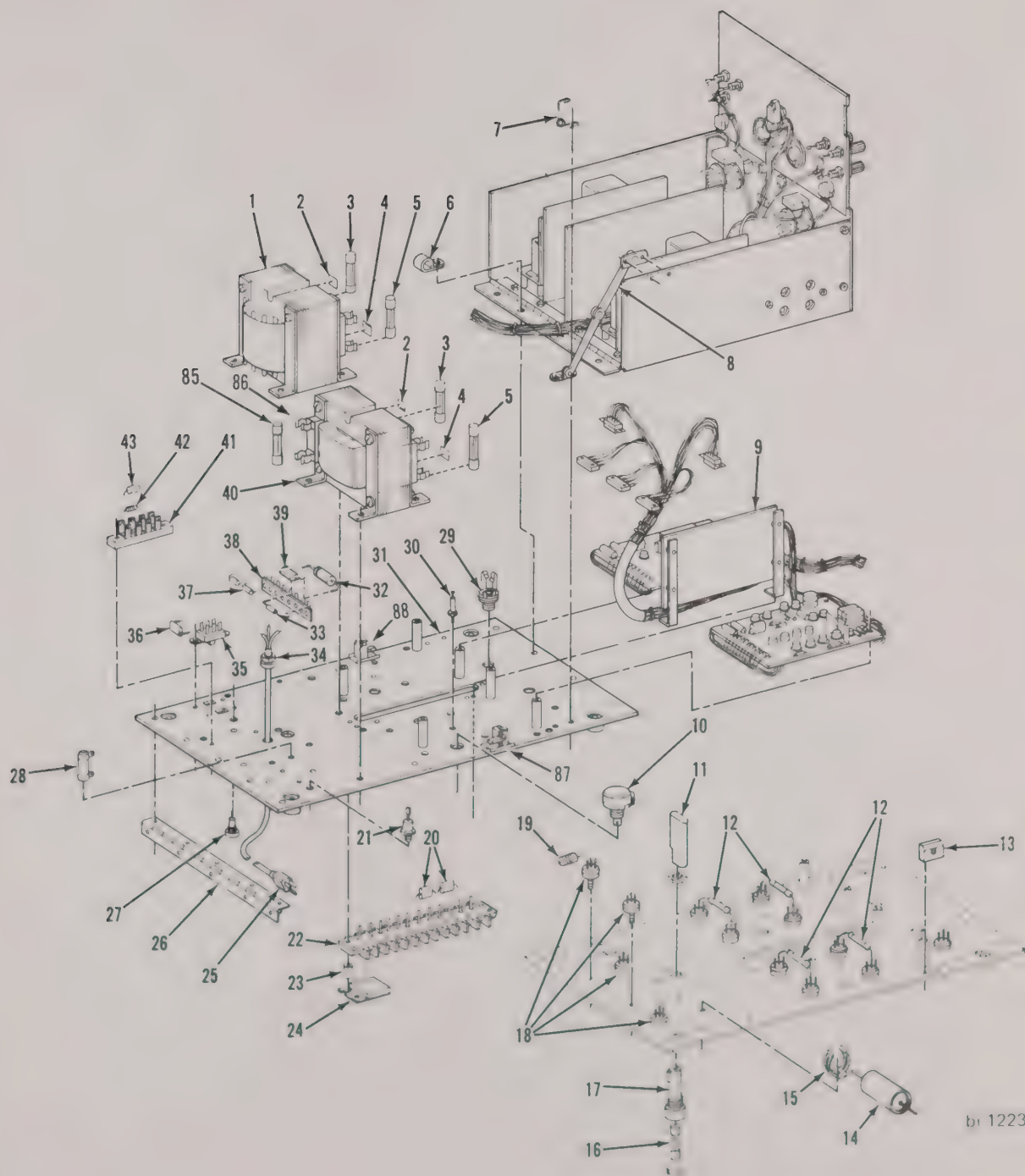


ELECTRICAL ASSEMBLY 846599 — Figure 9-3A



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ELECTRICAL ASSEMBLY 846599 -- Figure 9-3B

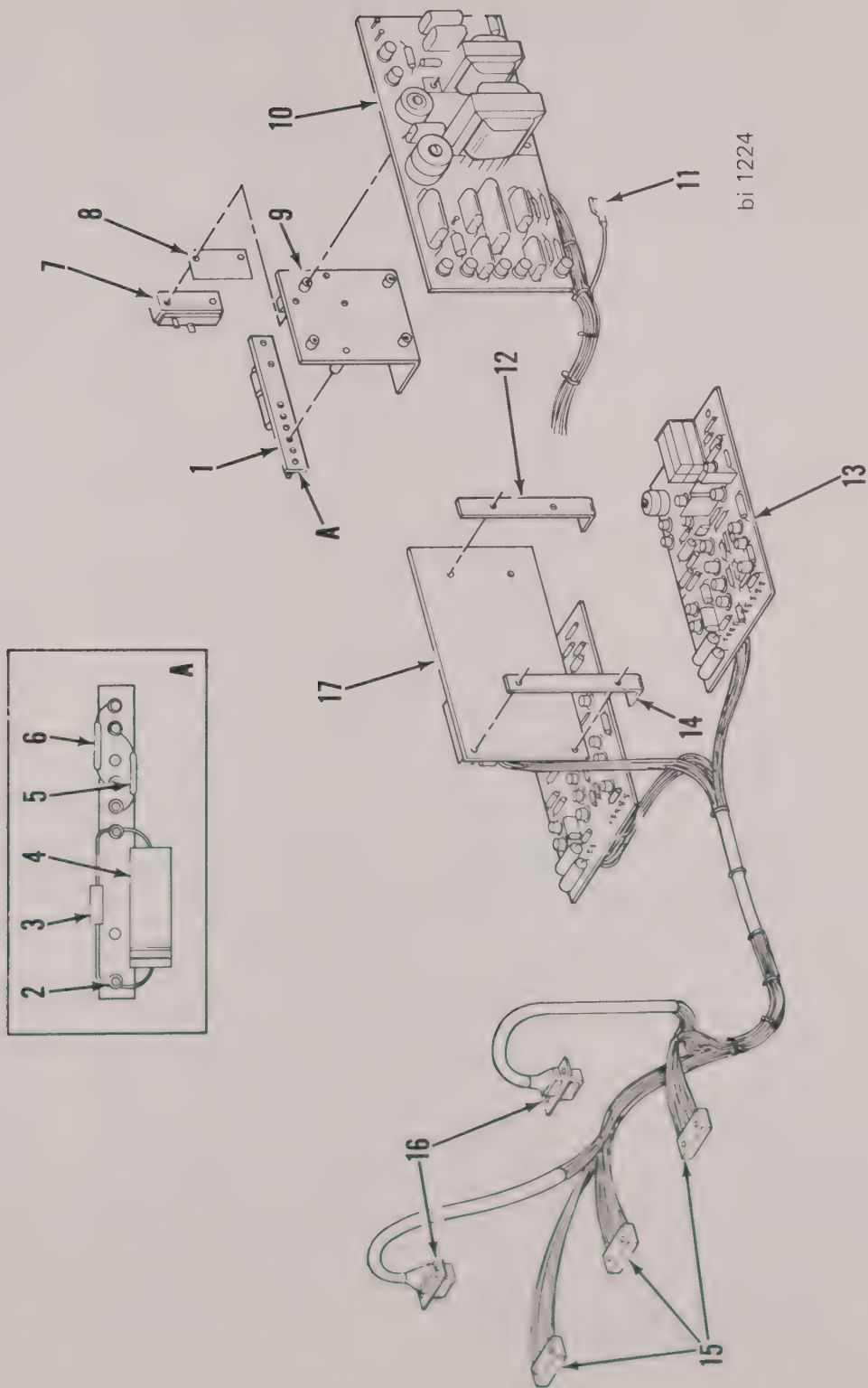


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ELECTRICAL ASSEMBLY 846599 -- Figure 9-3B

EXPLODED VIEW PARTS LIST
HARNESS ASSEMBLY 846583 — Figure 9-4

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Board Asm	646867	
2	Board Asm	646866	
3	Resistor, Fixed	5-115557-333	R-802
4	Capacitor	231707-207	C-801
5	Resistor, Fixed	1-128182-1001	R-801
6	Resistor, Fixed	1-128182-3301	R-803
7	Resistor, Vari	243380-202	R-9
8	Insulator	246883	
9	Support Bracket	645093	
10	Network Asm, Osc (see Figure 9-5)	846535	
	Network Asm, Osc (see Figure 9-5)	846246 (used on Mark 280-04,-14)	
11	Terminal Lug	265840-1	
12	Bracket Asm	243502-910	
13	Network Amplifier Asm (see Figure 9-10)	846461	
14	Bracket Asm	243503-910	
15	Connector	130168	J-3,J-4,J-5
16	Connector	244550	J-2
17	Network Asm, 20 KC Osc (see Figure 9-12)	846584	

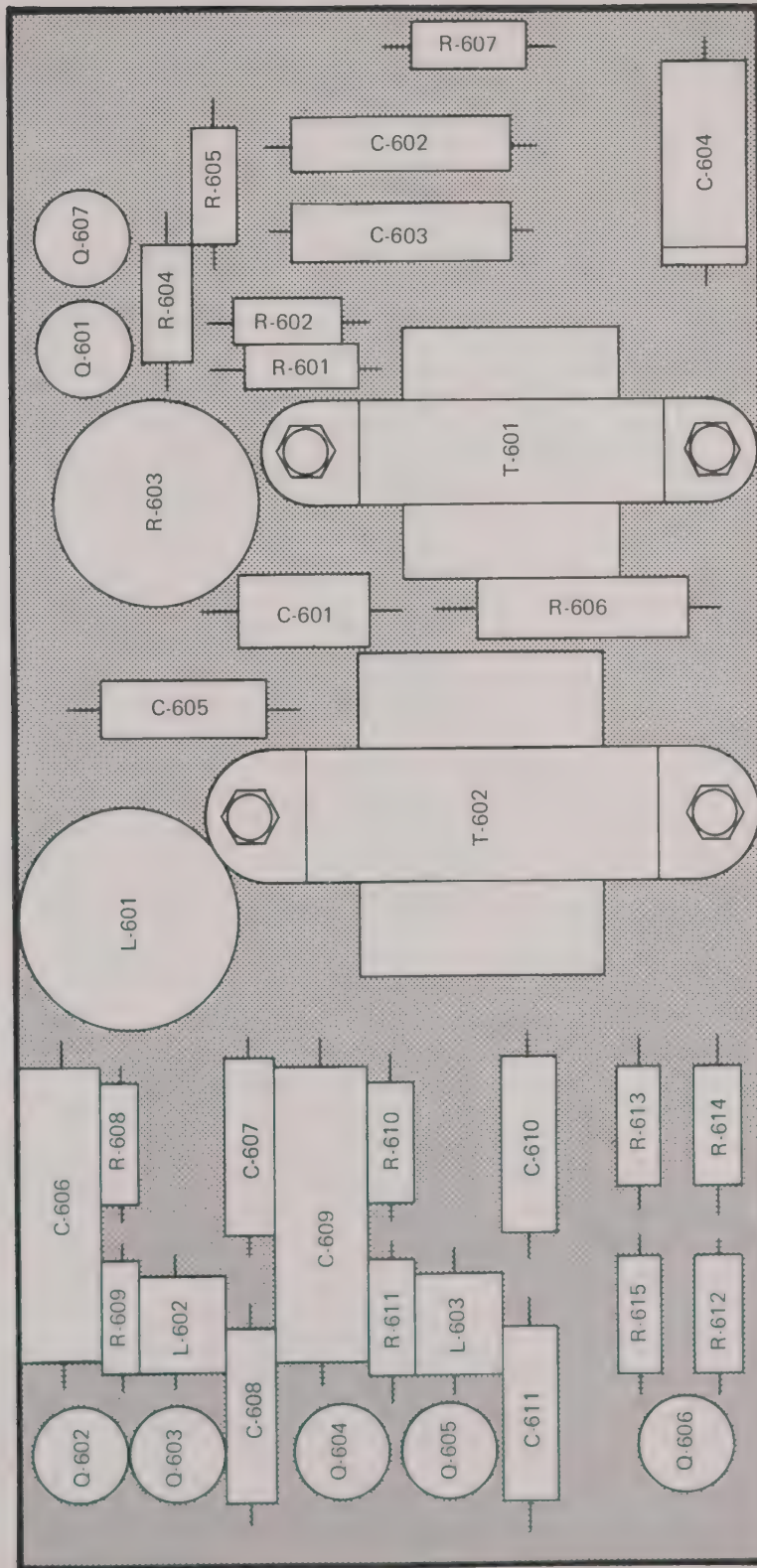


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HARNESS ASSEMBLY 846583 --- Figure 9-4

EXPLODED VIEW PARTS LIST
NETWORK ASM, OSC — Figure 9-5

SYMBOL NO	DESCRIPTION	PART NUMBER
C-601	Capacitor	243336-304
C-601	Capacitor	10-241145-205 (used on Mark 280-04,-14)
C-602	Capacitor	10-241145-105
C-602	Capacitor	10-241145-105 (used on Mark 280-04,-14)
C-603	Capacitor	10-241145-105
C-604	Capacitor	231922-256
C-605	Capacitor	1-241145-804
C-606	Capacitor	10-241145-205
C-606	Capacitor	262585-475 (used on Mark 280-04,-14)
C-607	Capacitor	10-241145-404
C-608	Capacitor	10-241145-404
C-609	Capacitor	10-241145-205
C-609	Capacitor	262585-475 (used on Mark 280-04,-14)
C-610	Capacitor	10-241145-404
L-601	Inductor	643887-10
L-602	Reactor	243179
L-603	Reactor	243179
Q-601	Transistor	242323
Q-602	Transistor, 2N1997	247347
Q-603	Transistor, 2N1997	247347
Q-604	Transistor, 2N1997	247347
Q-605	Transistor, 2N1997	247347
Q-606	Transistor, 2N1194	243920-4
Q-607	Transistor, 2N1194	242323
R-601	Resistor, Fixed	1-128182-9001
R-601	Resistor, Fixed	235724-502 (used on Mark 280-04,-14)
R-602	Resistor, Fixed	5-115557-820
R-602	Resistor, Variable	235724-502 (used on Mark 280-04,-14)
R-603	Resistor, Variable	248813-202
R-603	Resistor, Fixed	5-115557-821 (used on Mark 280-04,-14)
R-604	Resistor, Fixed	1-128182-9001
R-604	Resistor, Fixed	5-115558-222 (used on Mark 280-04,-14)
R-605	Resistor, Fixed	5-115557-820
R-606	Resistor, Fixed	5-119370-102
R-607	Resistor, Fixed	5-115557-821
R-608	Resistor, Fixed	5-115557-392
R-609	Resistor, Fixed	5-115557-122
R-610	Resistor, Fixed	5-115557-392
R-611	Resistor, Fixed	5-115557-122
R-612	Resistor, Fixed	1-128182-1002
R-613	Resistor, Fixed	1-128182-1501
R-614	Resistor, Fixed	1-128182-5600
R-615	Resistor, Fixed	1-128182-1001
T-601	Transformer	346459
T-602	Transformer	232354
T-603	Transformer	232346 (used on Mark 280-04,-14)



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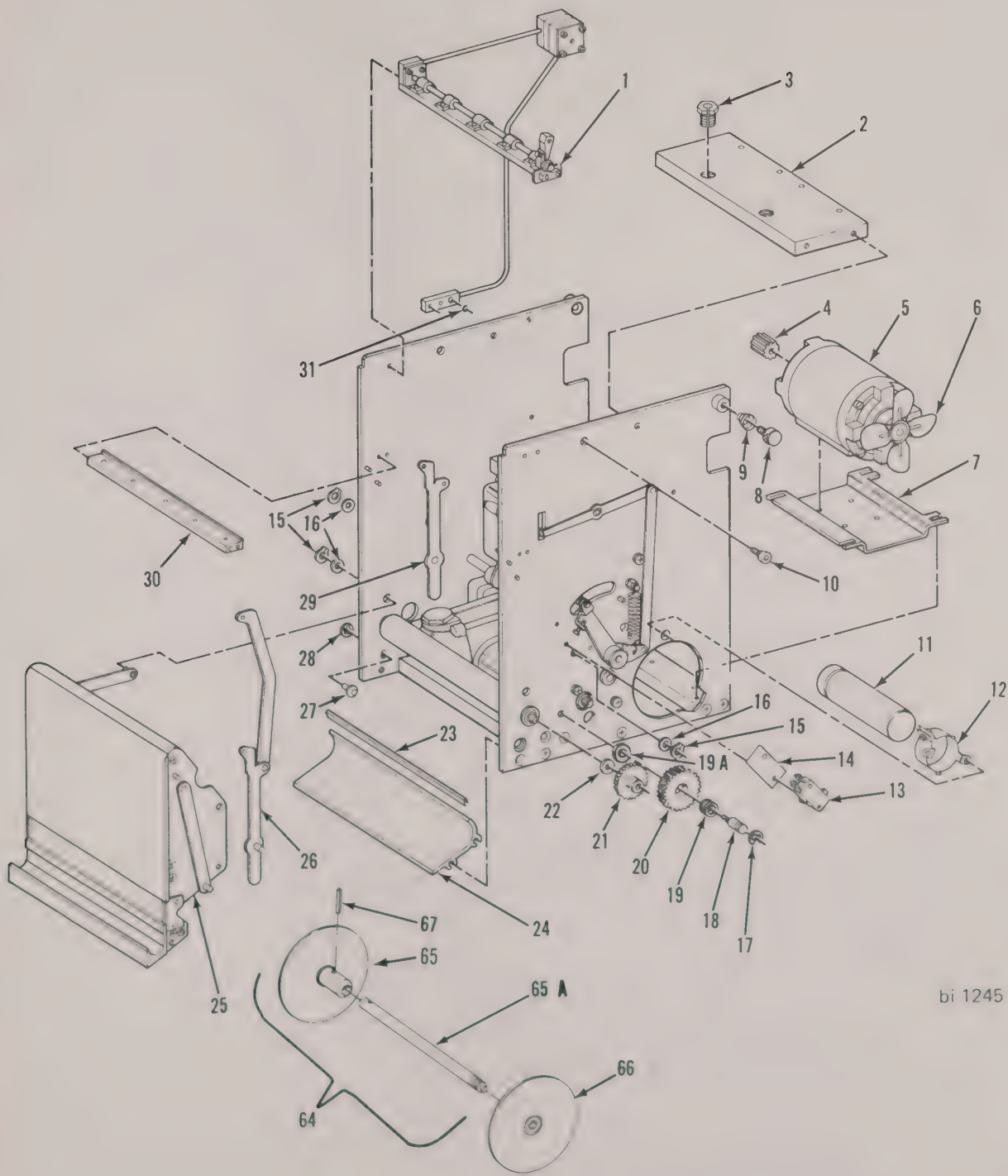
NETWORK ASM, OSC — Figure 9-5

EXPLODED VIEW PARTS LIST
RECORDER SUBASM 846431 — Figure 9-6A & 9-6B

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Manifold Asm	844361 (see Figure 9-7)	
2	Bar, Mounting	343600	
3	Bushing	243602	
4	Pulley, Motor	243778	
5	Motor, A.C.	344070 (used on Mark 280-01,-10)	B-1
5	Motor (alternate for 344070)	347415 & 346909	B-1
5	Motor, A.C.	344353 (used on Mark 280-05,-15)	B-1
5	Motor (alternate for 344353)	347248	B-1
5	Motor, A.C.	349087 (used on Mark 280-04,-14)	B-1
5	Motor, A.C.	363466 (used on Mark 280-06,-16)	B-1
6	Impeller Fan	244076	
6	Impeller Fan	264355 (used on Mark 280-04,-14)	
7	Bracket, Motor Mounting	346884	
8	Screw	243521	
9	Spring	246490	
10	Screw, Shoulder	240132	
11	Capacitor	247552	C-50
12	Clamp, Capacitor	113876-2	
13	Switch, Sensitive SPDT	128004	S-5
14	Insulator	243998	
15	Ring, Retaining	1-227070-9	
16	Washer	127271	
17	Ring, Retaining	2-240731-11	
18	Post, Mounting	243736	
19A	Washer	243739	
19	Bearing, Roller	232250-2	
20	Gear, Spur	243515	
21	Gear, Spur	243519	
22	Washer, Plain	116796	
23	Deflector, Paper	249668	
24	Chute, Paper	343732	
25	Table Asm, Writing (see Figure 9-8)	843825-10	
26	Arm Asm	243610-910	
27	Button, Detent	243507	
28	Ring, Retaining	1-127657-5	
29	Lever Asm	243611-910	
30	Bar, Mounting	243588	
31	Packing, Performed	232780-4	
32	Plate Asm	746404	
33	Motor Start Capacitor (used with Motor 344070,344353)	243091-305	C 61
33	Motor Start Capacitor (used with Motor 346909)	243091-405	C-61
33	Motor Start Capacitor (used with Motor 347415)	243091-505	C-61
33	Motor Start Capacitor (used with Motor 347248)	243091-605	C 61
33	Motor Start Capacitor (used with Motor 349087)	263395-205 (used on Mark 280-04,-14)	C 61
33	Motor Start Capacitor (used with Motor 363466)	263890-505 (used on Mark 280-06,-16)	C 61
33A	Bracket, Capacitor	264373-1 (used on Mark 280-04,-14)	

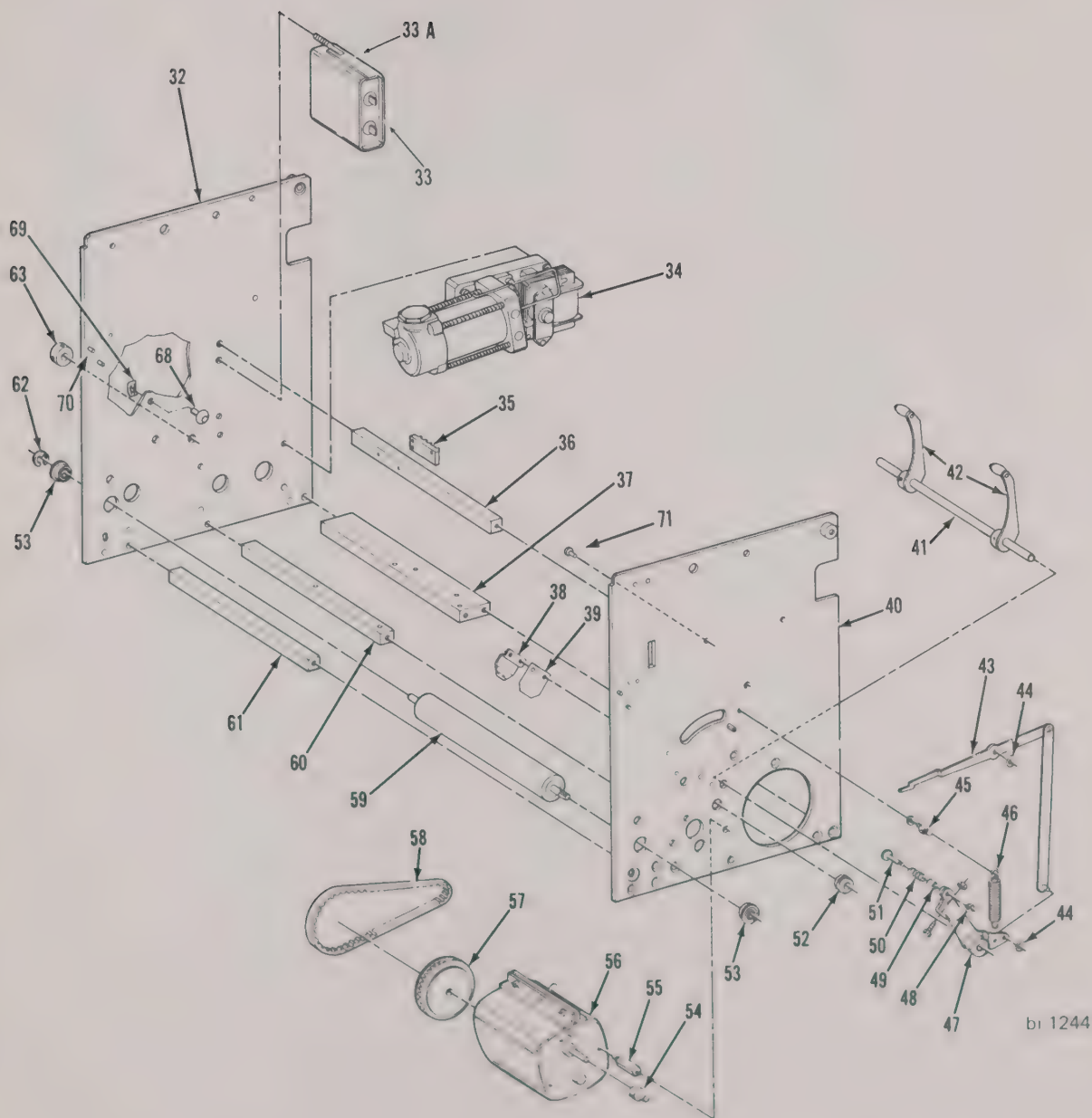
EXPLODED VIEW PARTS LIST (continued)
RECORDER SUBASM 846431 — Figure 9-6A & 9-6B

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
33A	Bracket, Capacitor	244546	
34	Ink Supply Asm	844245 (see Figure 9-9)	
34	Ink Supply Asm	863689 (used on Mark 280-06,-16)	
34	Ink Supply Asm	863344 (used on Mark 280-04,-14)	
34	Ink Supply Asm	863071 (used on Mark 280-05,-15)	
35	Terminal Board	265814-4	
36	Bar, Mounting, Event Marker	243559	
37	Bar, Hinge	343491	
38	Spring	243623	
39	Pad, Friction	243622	
40	Plate Asm	746405	
41	Shaft	243469	
42	Arm Asm, Sensor	743915-10	
43	Indicator Asm	644355	
44	Ring, Retaining	1-227070-3	
45	Support, Spring	241840	
46	Spring	243457	
47	Arm Subasm, Brake	743913-10	
48	Ring, Retaining	1-240731-2	
49	Bushing	263376	
50	Spring, Compression	244407	
51	Disk Asm, Friction	643919-10	
52	Grommet	123108-44	
53	Bearing, Ball	128721	
54	Gear, Spring	243520	
55	Post, Mounting Transmission	243583	
55	Post, Mounting Transmission	264219 (used on Mark 280-04,-14)	
56	Transmission Asm	844255	
56	Transmission Asm	RC-2148-16 (used on Mark 280-05,-15,-06,-16)	
56	Transmission Asm	12-2151-16 (used on Mark 280-04,-14)	
57	Pulley Asm	643785-10	
57	Pulley Asm	644218 (used on Mark 280-04,-14)	
58	Belt, Drive	243542-1	
59	Roller, Drive	343509	
60	Bar, Mounting	243494	
61	Bar, Support	243495	
62	Ring, Retaining	1-240731-10	
63	Collar, Shaft	243443	
64	Paper Supply Shaft Asm	744012	
65	Paper Supply Hub	683281	
65A	Paper Supply Shaft	243445	
66	Hub Asm	744015	
67	Pin, Grooved	3-119820-709	
68	Bumper	243440	
69	Nut, Push-on	243856-1	
70	Pin	240161-312	
71	Rivet	11-125110-1104	



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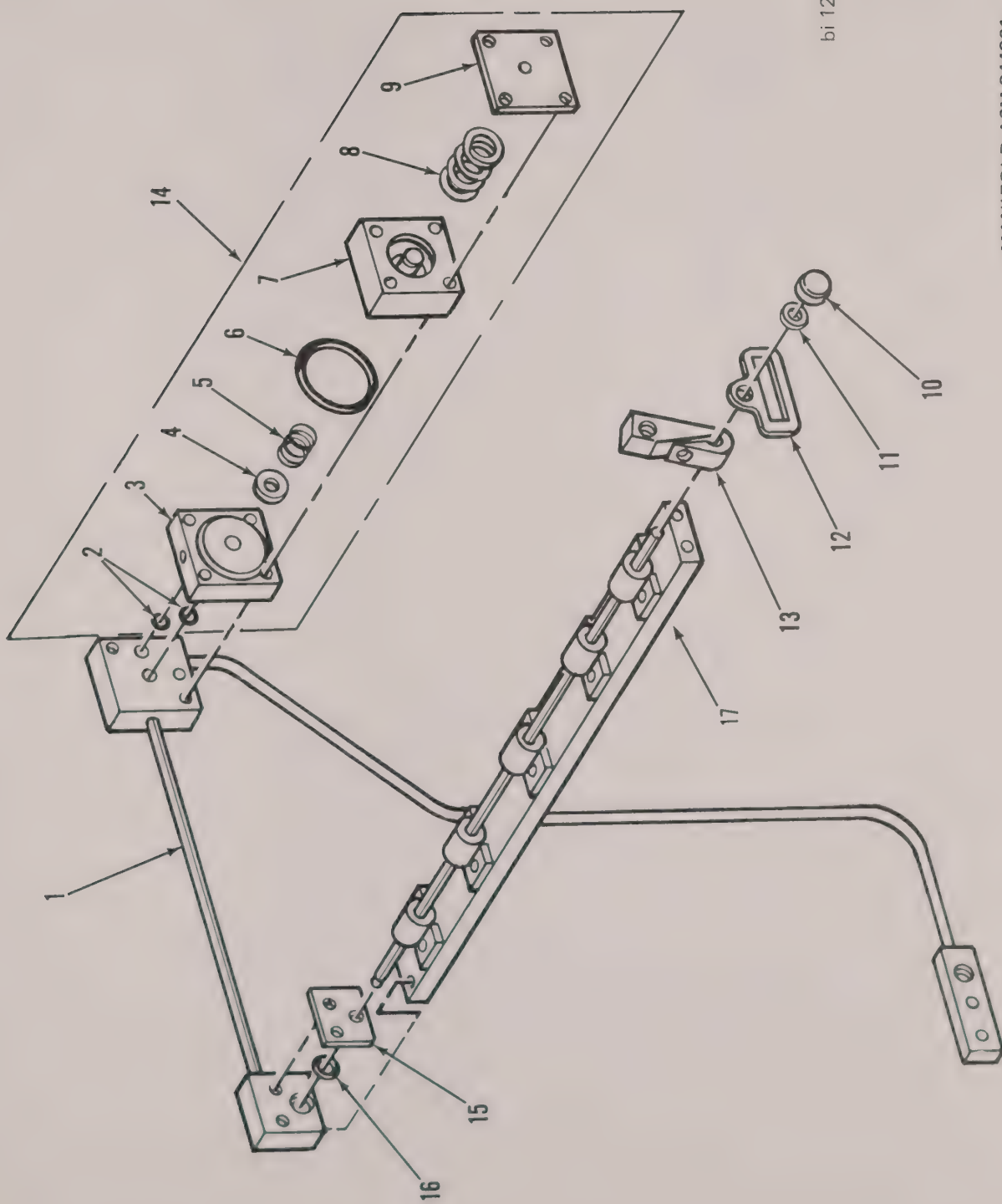
RECORDER SUBASM 846431 – Figure 9-6A



RECORDER SUBASM 846431 — Figure 9-6B

**FIGURE 9-7 – EXPLODED VIEW PARTS LIST
MANIFOLD ASM 844361**

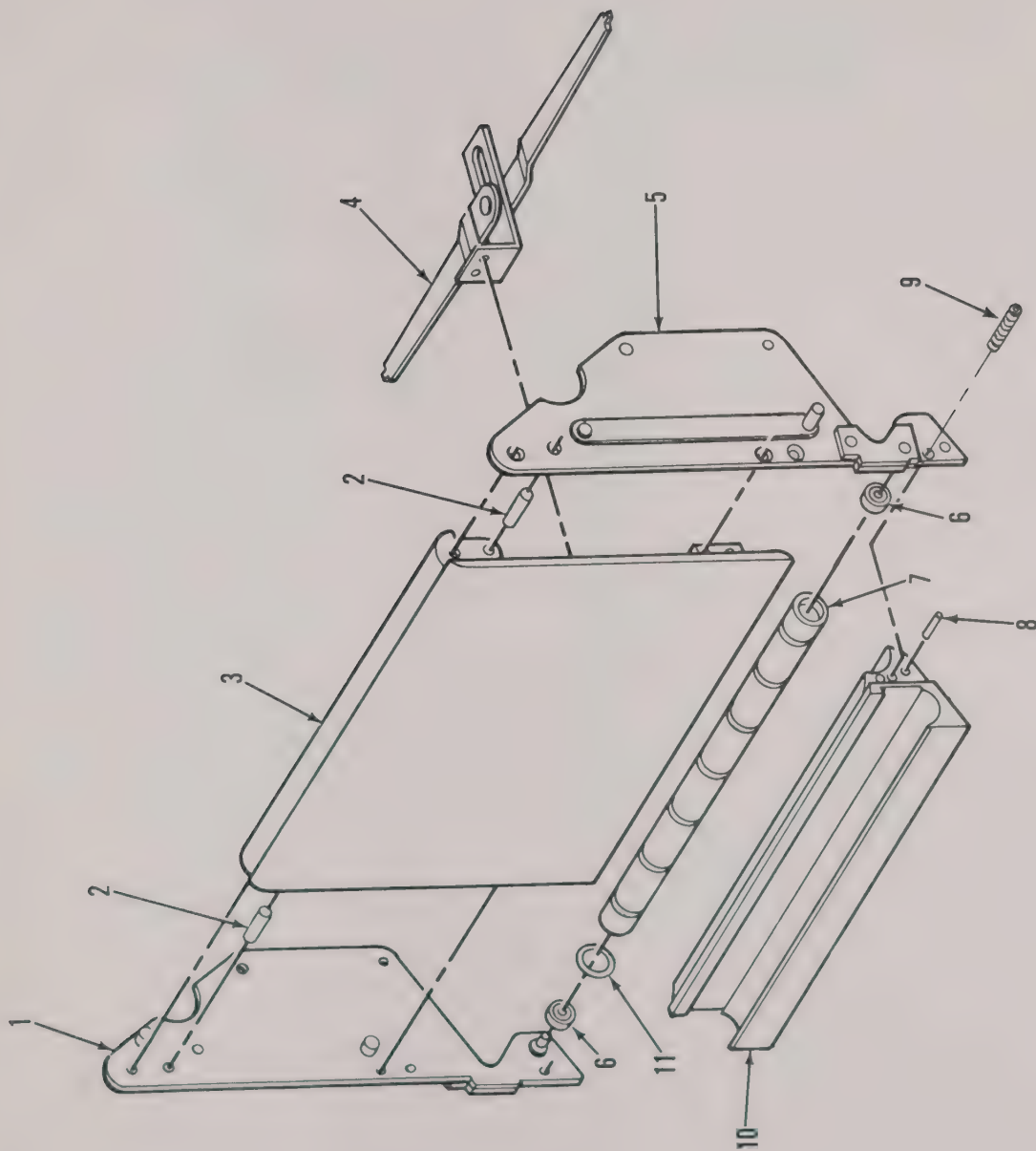
REF NO	DESCRIPTION	PART NUMBER
1	Tube Asm	844662
2	Packing, Preformed	232780-2
3	Body, Valve	344660
4	Valve, Check	244655
5	Spring	244657
6	Packing, Preformed	232780-7
7	Bellows Asm	744679
8	Spring, Compression	244688
9	Cover	244673
10	Cap, End	241837
11	Packing, Preformed	232780-4
12	Support, Manifold	242421
13	Arm, Manifold	241836
14	Valve Asm, Complete	666895
15	Retainer, Seal	241845
16	Packing, Preformed	232780-4
17	Bar, Manifold Asm	849546



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FIGURE 9-8 — EXPLODED VIEW PARTS LIST
 WRITING TABLE ASSEMBLY 843825

REF NO	DESCRIPTION	PART NUMBER
1	Support Asm, Left	343617-910
2	Pin, Dowel	2-214148-102
3	Bar, Writing	343650-910
4	Paper Release Asm	743807-10
5	Support Asm, Right	343616-910
6	Bearing	1-210761-6
7	Roll, Pressure	343620
8	Pin, Roll	4-112468-9
9	Pin, Spring	129384-9
10	Pull Bar Asm	649667
11	Packing, Preformed	243867-1

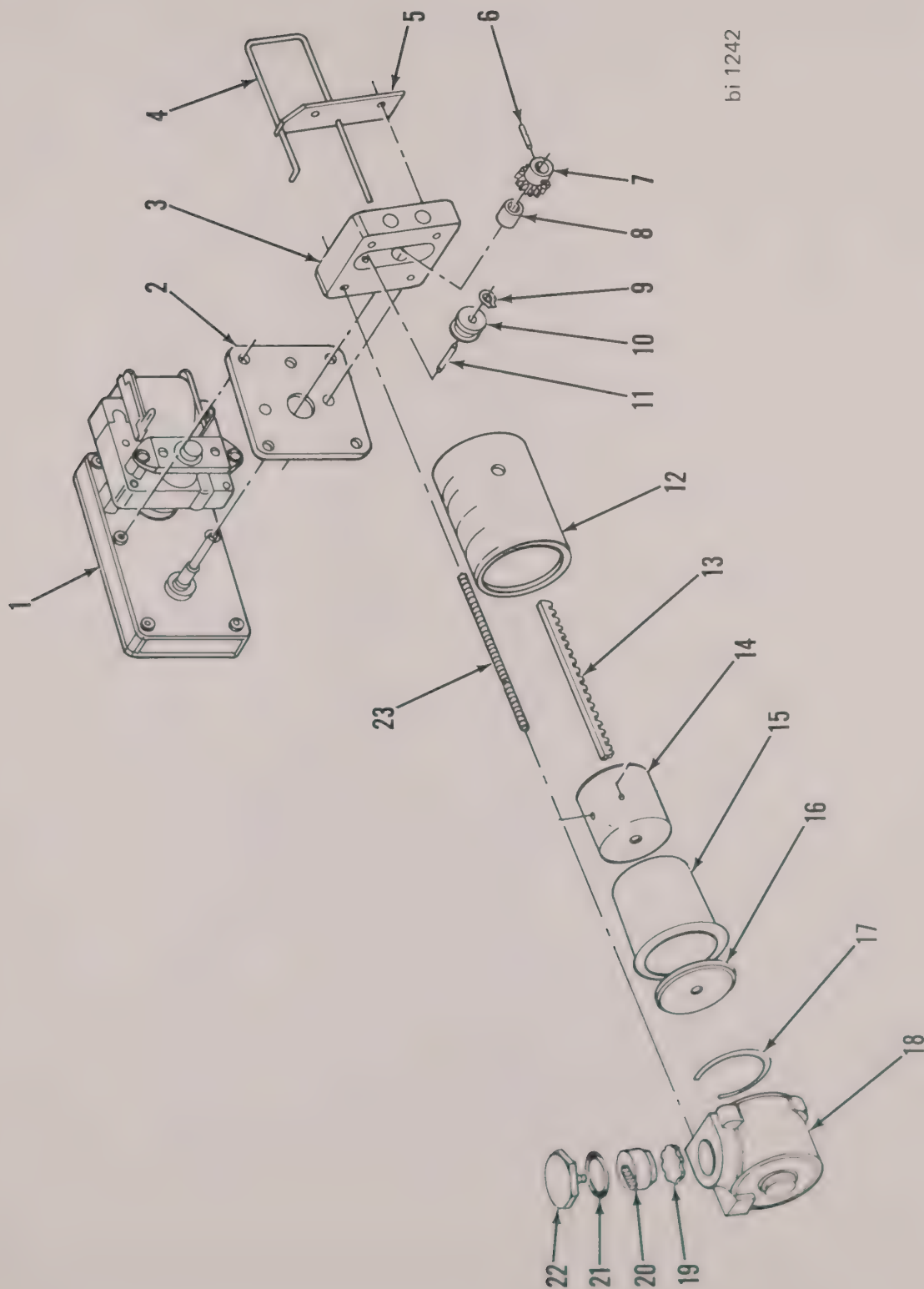


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WRITING TABLE ASSEMBLY 843825 – Figure 9-8

EXPLODED VIEW PARTS LIST
 INK SUPPLY ASSEMBLY 844245 – Figure 9-9

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Motor Asm, Ink Pump	866010 (used in Mark 280-01,-10)	B-703
1	Motor, A.C. Gear Head, 50 Hz	346052 (used in Mark 280-05,-15)	B-703
1	Motor, A.C. Gear Head, 400 Hz	863440 (used in Mark 280-04,-14)	B-703
1	Motor, A.C. Gear Head, 50 Hz, 230V	263632 (used in Mark 280-06,-16)	B-703
2	Plate Mtg	243937	
3	Plate Mtg	243936	
4	Pointer	247807	
5	Guide, Pointer	247808	
6	Pin, Roll	4-112468-19	
7	Gear, Spur	243826	
8	Bearing, Roller	232250-7	
9	Ring, Retaining	9-227070-3	
10	Guide, Gear Rack	243938	
11	Pin, Straight	240161-424	
12	Cylinder Asm, Ink	644223	
13	Gear, Rack	243828	
14	Piston	243821	
15	Diaphragm, Valve	243857	
16	Cap, Piston	243827	
17	Spring, Retainer	244220	
18	Chamber, Ink	444213	
19	Valve	244109	
20	Insert	344593	
21	Packing, Preformed	232780-7	
22	Screw, Cap	244592	
23	Stud, Continous Thread	243939	



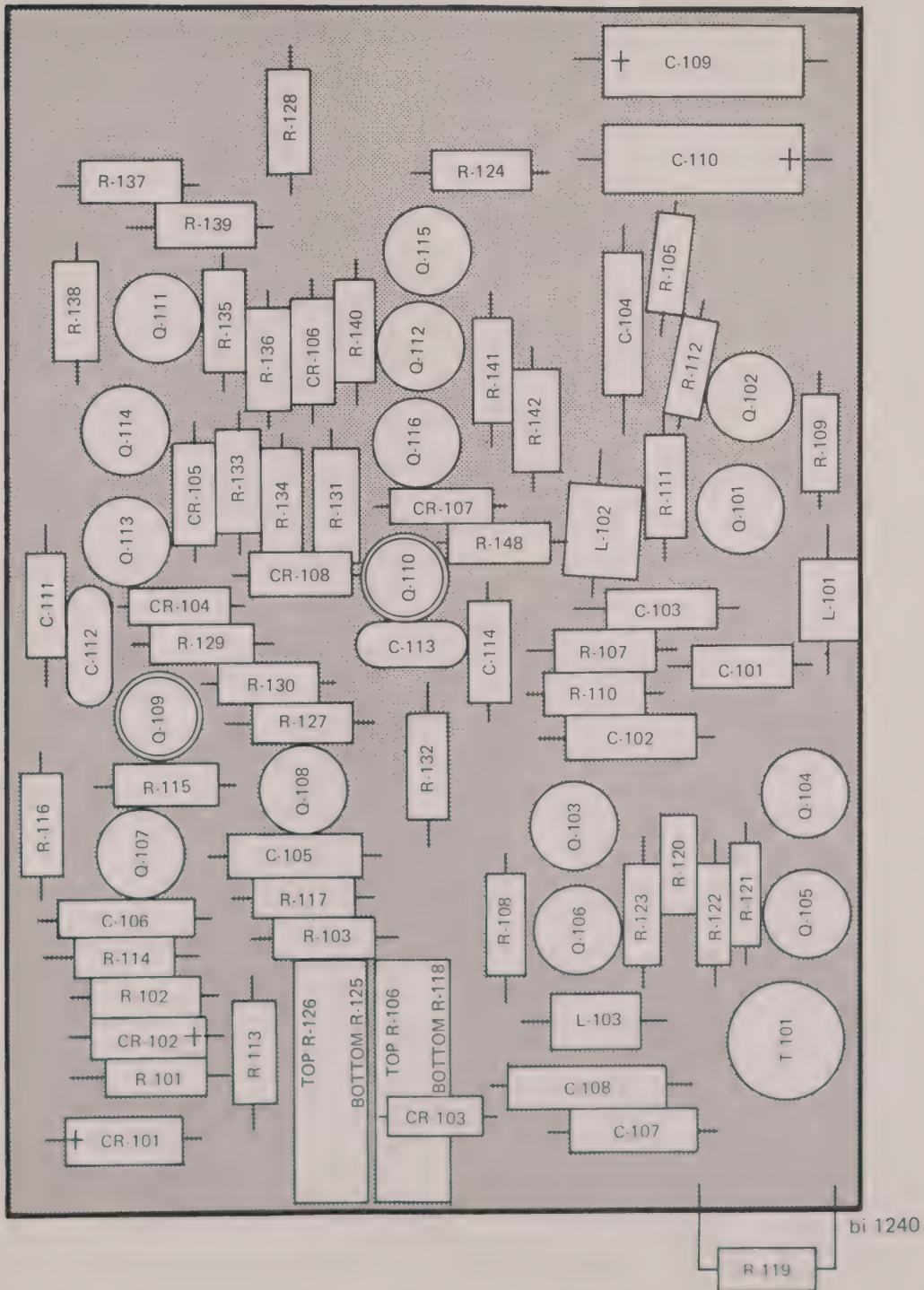
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EXPLODED VIEW PARTS LIST
NETWORK AMPLIFIER ASSEMBLY 846461 — Figure 9-10

SYMBOL NO	DESCRIPTION	PART NUMBER
	Limiter Circuit (see Figure 9-11)	745943
C-101	Capacitor	10-125904-602
C-102	Capacitor	10-125904-203
C-103	Capacitor	10-125904-602
C-104	Capacitor	10-241145-304
C-105	Capacitor	10-241145-503
C-106	Capacitor	10-125904-102
C-107	Capacitor	10-241145-403
C-108	Capacitor	10-125904-303
C-109	Capacitor	231922-356
C-110	Capacitor	231922-356
C-111	Capacitor	10-125904-332
C-112	Capacitor	10-231854-271
C-113	Capacitor	10-231854-271
C-114	Capacitor	10-125904-332
CR-101	Semiconductor	244311
CR-102	Semiconductor	244311
CR-103	Semiconductor	244311
CR-104	Semiconductor	244311
CR-105	Semiconductor	244311
CR-106	Semiconductor	244311
CR-107	Semiconductor	244311
CR-108	Semiconductor	231869
L-101	Reactor	243179
L-102	Reactor	243179
L-103	Reactor	243179
Q-101	Transistor, 2N1370	231884
Q-102	Transistor, 2N1193	243920-3
Q-103	Transistor, 2N1303	240236
Q-104	Transistor, 2N1302	240237
Q-105	Transistor, 2N1303	240236
Q-106	Transistor, 2N1302	240237
Q-107	Transistor	242323
Q-108	Transistor	242323
Q-109	Transistor	247149
Q-110	Transistor	247149
Q-111	Transistor	242323
Q-112	Transistor	242323
Q-113	Transistor	242323
Q-114	Transistor, 2N1186	243009-28
Q-115	Transistor, 2N1186	243009-28
Q-116	Transistor	242323

EXPLODED VIEW PARTS LIST (continued)
NETWORK AMPLIFIER ASSEMBLY 846461 — Figure 9-10

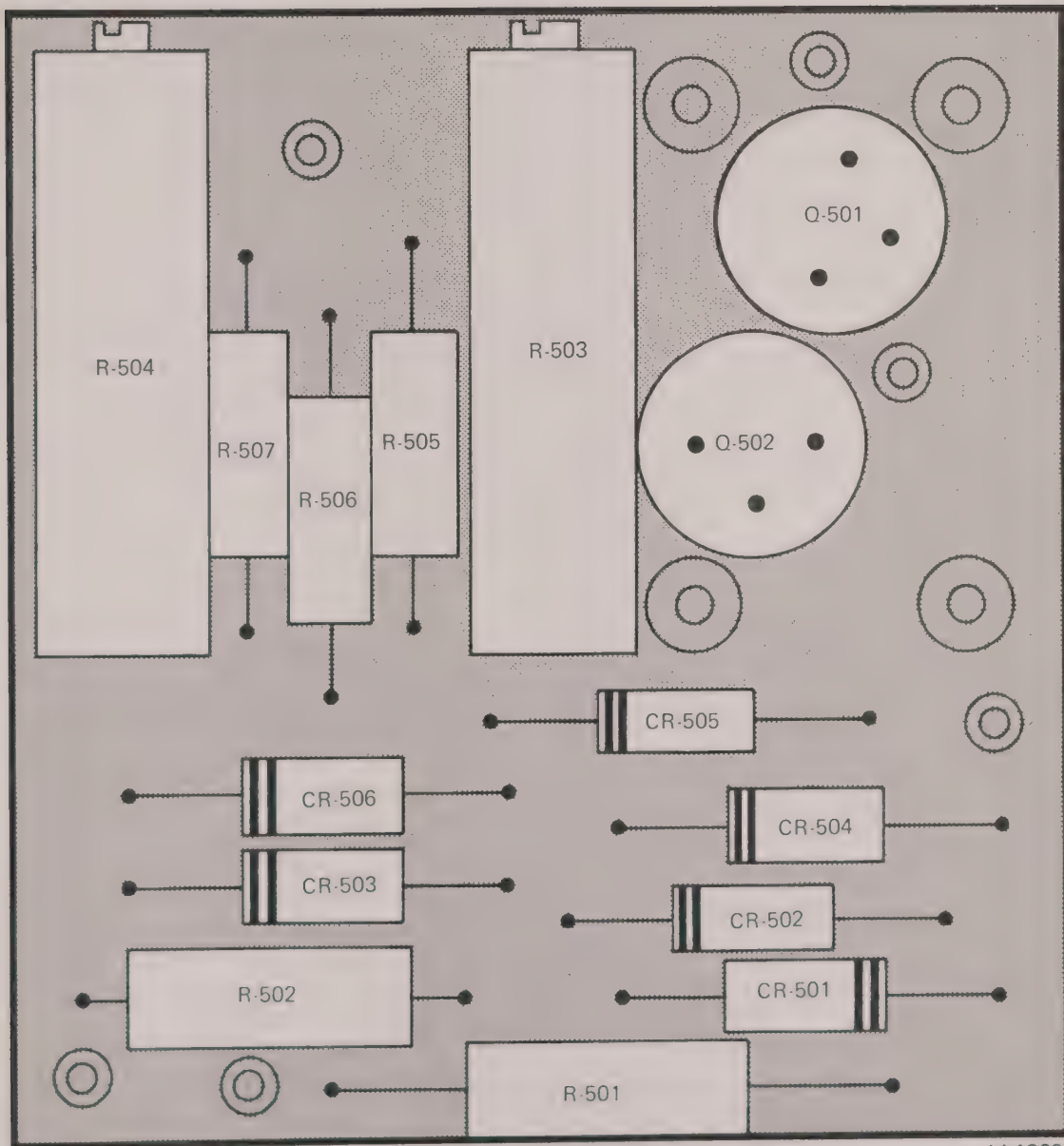
SYMBOL NO	DESCRIPTION	PART NUMBER
R-101	Resistor, Fixed	1-128182-2752
R-102	Resistor, Fixed	1-128182-5002
R-103	Resistor, Fixed	1-128182-4092
R-105	Resistor, Fixed	1-128182-1002
R-106	Resistor, Variable	243379-104
R-107	Resistor, Fixed	1-128182-4702
R-108	Resistor, Fixed	5-115557-682
R-109	Resistor, Fixed	1-128182-3902
R-110	Resistor, Fixed	5-115557-103
R-111	Resistor, Fixed	5-115557-123
R-112	Resistor, Fixed	5-115557-272
R-113	Resistor, Fixed	1-128182-1103
R-114	Resistor, Fixed	5-115557-155
R-115	Resistor, Fixed	1-128182-6802
R-116	Resistor, Fixed	1-128182-2504
R-117	Resistor, Fixed	1-128182-2003
R-118	Resistor, Variable	243379-203
R-119	Resistor, Fixed	5-115557-101
R-120	Resistor, Fixed	1-128182-1002
R-121	Resistor, Fixed	1-128182-1002
R-122	Resistor, Fixed	1-128182-1002
R-123	Resistor, Fixed	1-128182-1002
R-124	Resistor, Fixed	5-115557-102
R-125	Resistor, Variable	243379-203
R-126	Resistor, Variable	243379-203
R-127	Resistor, Fixed	1-128182-6802
R-128	Resistor, Fixed	5-115557-332
R-129	Resistor, Fixed	1-128182-4702
R-130	Resistor, Fixed	1-128182-3502
R-131	Resistor, Fixed	1-128182-3502
R-132	Resistor, Fixed	1-128182-4702
R-133	Resistor, Fixed	1-128182-1502
R-134	Resistor, Fixed	1-128182-1502
R-135	Resistor, Fixed	1-128182-1001
R-136	Resistor, Fixed	1-128182-1001
R-137	Resistor, Fixed	5-115557-222
R-138	Resistor, Fixed	5-115557-390
R-139	Resistor, Fixed	50-128182-3030
R-140	Resistor, Fixed	50-128182-3030
R-141	Resistor, Fixed	5-115557-390
R-142	Resistor, Fixed	5-115557-222
R-148	Resistor, Fixed	5-115557-911
T-101	Transformer	243590-910



NETWORK AMPLIFIER ASM 846461 – Figure 9-10

EXPLODED VIEW PARTS LIST
LIMITER CIRCUIT ASM 745943 — Figure 9-11

SYMBOL NO	DESCRIPTION	PART NUMBER
CR-501	Semiconductor, 1N277	244311
CR-502	Semiconductor, 1N458	244896
CR-503	Semiconductor, 1N277	244311
CR-504	Semiconductor, 1N277	244311
CR-505	Semiconductor, 1N458	244896
CR-506	Semiconductor, 1N277	244311
Q-501	Transistor	242323
Q-502	Transistor	242323
R-501	Resistor, Fixed	1-128182-91671
R-502	Resistor, Fixed	1-128182-1103
R-503	Resistor, Variable	244771-502
R-504	Resistor, Variable	244771-502
R-505	Resistor, Fixed	5-115557-822
R-506	Resistor, Fixed	5-115557-122
R-507	Resistor, Fixed	5-115557-472

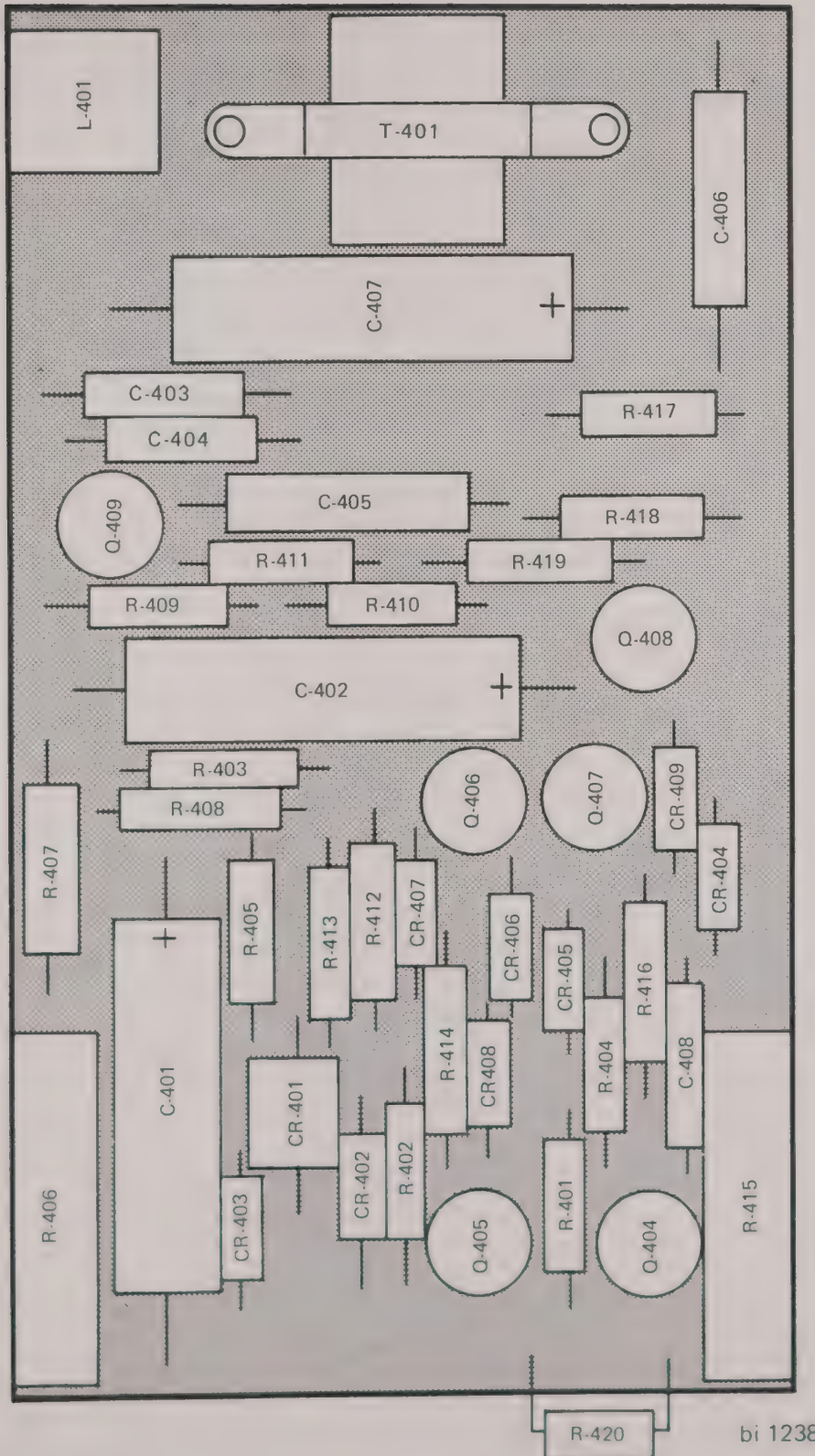


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LIMITER CIRCUIT ASM 745943 — Figure 9-11

EXPLODED VIEW PARTS LIST
NETWORK OSCILLATOR 846584 -- Figure 9-12

SYMBOL NO	DESCRIPTION	PART NUMBER
C-401	Capacitor	243006-356
C-402	Capacitor	231922-107
C-403	Capacitor	10-125904-332
C-404	Capacitor	10-125904-332
C-405	Capacitor	10-125904-154
C-406	Capacitor	5-130488-503
C-407	Capacitor	243006-356
C-408	Capacitor	10-241145-143
CR-401	Semiconductor	240333
CR-402	Semiconductor	242853
CR-403	Semiconductor	242853
CR-404	Semiconductor	241133
CR-405	Semiconductor	249747
CR-406	Semiconductor	241133
CR-407	Semiconductor	231869
CR-408	Semiconductor	231869
CR-409	Semiconductor	231869
L-401	Coil	242009-1
Q-404	Transistor, 2N1371	240332
Q-405	Transistor, 2N1371	240332
Q-406	Transistor, 2N1370	231884
Q-407	Transistor, 2N1370	231884
Q-408	Transistor, 2N1370	231884
Q-409	Transistor, 2N1193	243920-3
R-401	Resistor, Fixed	5-115557-273
R-402	Resistor, Fixed	5-115558-470
R-403	Resistor, Fixed	5-115557-272
R-404	Resistor, Fixed	5-115557-181
R-405	Resistor, Fixed	5-115557-181
R-406	Resistor, Variable	240539-501
R-407	Resistor, Fixed	5-115558-152
R-408	Resistor, Fixed	5-115557-333
R-409	Resistor, Fixed	5-115557-333
R-410	Resistor, Fixed	5-115557-103
R-411	Resistor, Fixed	5-115557-103
R-412	Resistor, Fixed	5-115557-331
R-413	Resistor, Fixed	5-115557-222
R-414	Resistor, Fixed	5-115557-687
R-415	Resistor, Variable	240539-202
R-416	Resistor, Fixed	5-115557-680
R-417	Resistor, Fixed	5-115557-120
R-418	Resistor, Fixed	5-115557-331
R-419	Resistor, Fixed	5-115557-562
R-420	Resistor, Fixed	5-115557-123
T-401	Transformer	243188

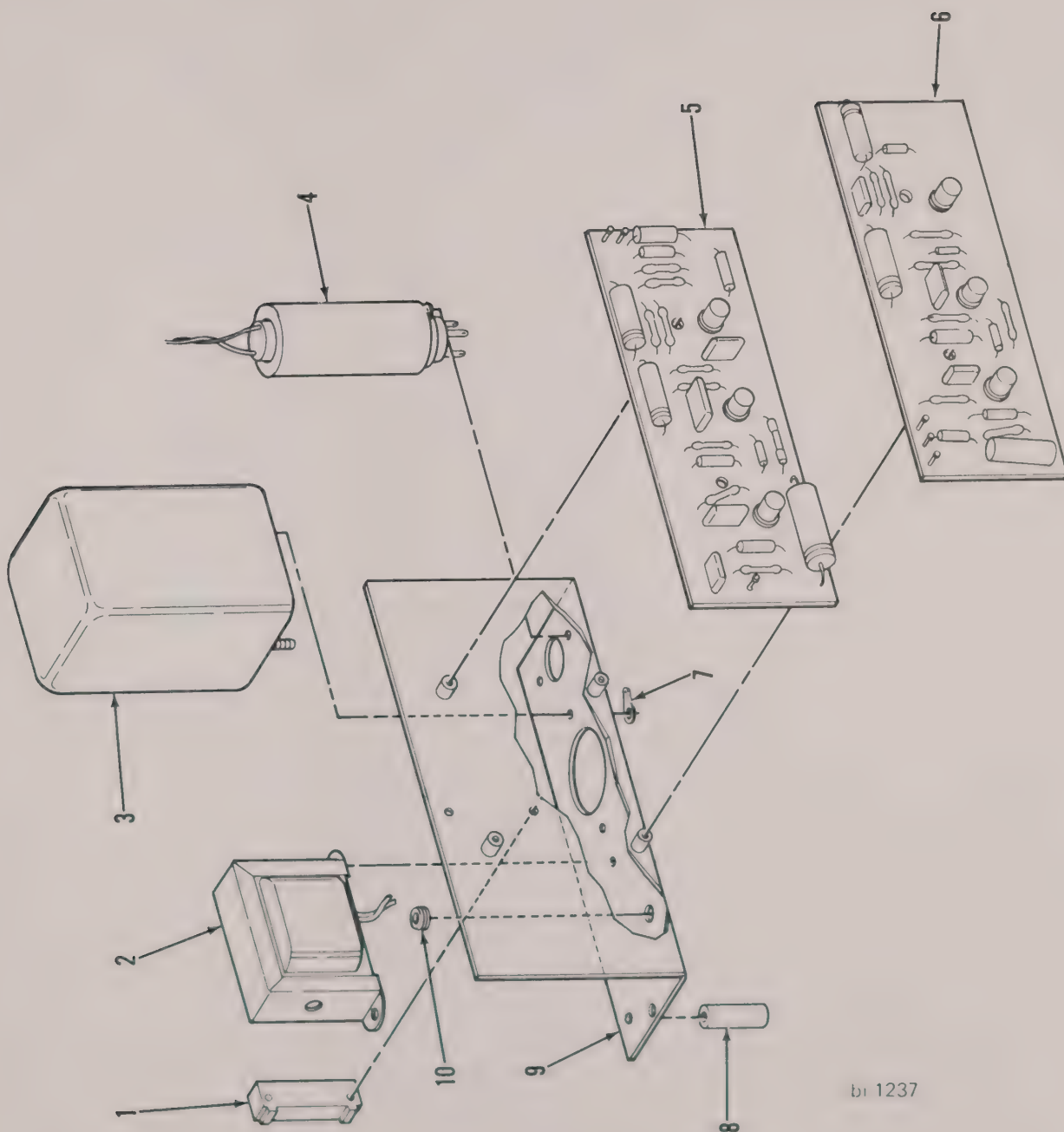


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NETWORK OSCILLATOR, 20 KC – Figure 9-12

EXPLODED VIEW PARTS LIST
PREAMPLIFIER SUBASM 846474 – Figure 9-13

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Resistor, Variable	243380-501	R-4
2	Transformer	243839	T-9
3	Transformer	232223	T-1
4	Chopper	231753	G-1
5	Amplifier Asm (see Figure 9-14)	843880-10	
6	Amplifier Asm (see Figure 9-15)	843879-10	
7	Lug, Soldering	11528-105	
8	Spacer, Threaded	243783	
9	Bracket Asm	643782-10	
10	Grommet	123108-22	

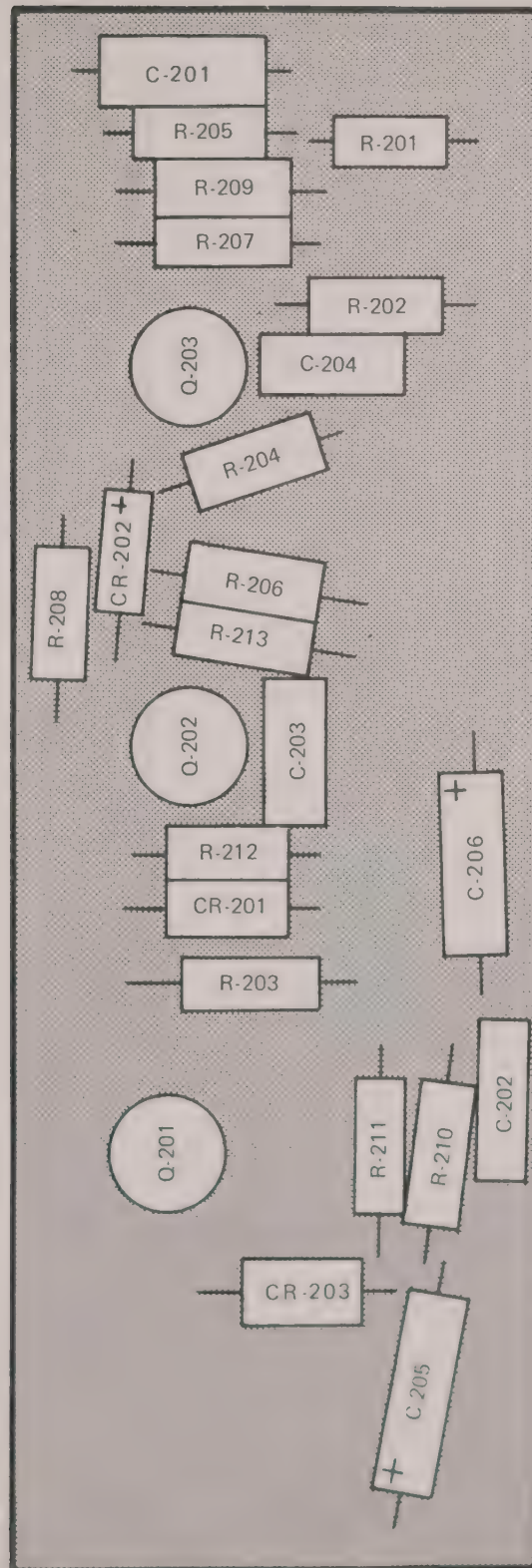


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PREAMPLIFIER SUBASM 846474 — Figure 9-13

EXPLODED VIEW PARTS LIST
AMPLIFIER ASM, PREAMPLIFIER INPUT 843880 -- Figure 9-14

SYMBOL NO	DESCRIPTION	PART NUMBER
C-201	Capacitor	241137-2005
C-202	Capacitor	10-231954-560
C-203	Capacitor	10-231953-821
C-204	Capacitor	10-231853-821
C-205	Capacitor	231877-2005
C-206	Capacitor	243228-356
CR-201	Semiconductor	244311
CR-202	Semiconductor	231869
CR-203	Semiconductor	231869
Q-201	Transistor, 2N1374	231886
Q-202	Transistor, 2N1370	231884
Q-203	Transistor, 2N1370	231884
R-201	Resistor, Fixed	5-115557-272
R-202	Resistor, Fixed	1-128182-2702
R-203	Resistor, Fixed	1-128182-3602
R-204	Resistor, Fixed	1-128182-1802
R-205	Resistor, Fixed	1-128182-9001
R-206	Resistor	5-115557-182
R-207	Resistor	5-115557-182
R-208	Resistor	50-128182-56R0
R-209	Resistor	1-128182-3002
R-210	Resistor	1-128182-3902
R-211	Resistor	1-128182-1303
R-212	Resistor	1-128182-3602
R-213	Resistor	1-128182-3602

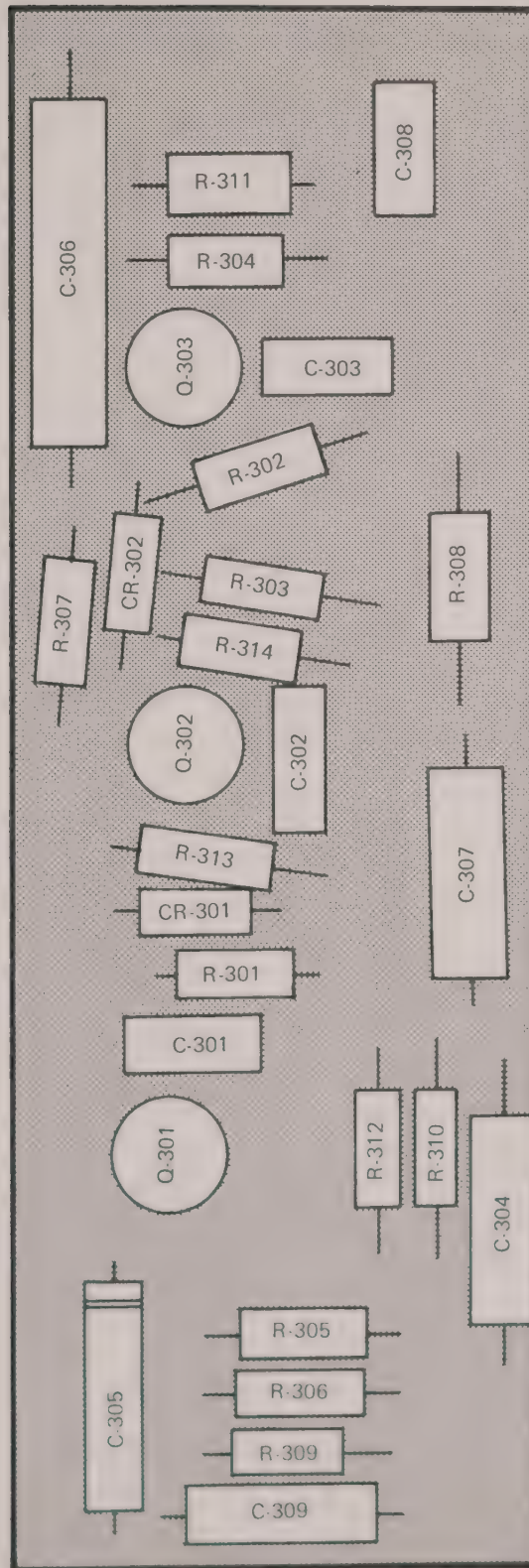


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AMPLIFIER ASM,
PREAMPLIFIER INPUT 843880 — Figure 9-14

EXPLODED VIEW PARTS LIST
AMPLIFIER ASM, PREAMPLIFIER OUTPUT 843879 — Figure 9-15

SYMBOL NO	DESCRIPTION	PART NUMBER
C-301	Capacitor	10-231853-561
C-302	Capacitor	10-231852-162
C-303	Capacitor	10-231853-821
C-304	Capacitor	243228-356
C-305	Capacitor	10-125904-332
C-306	Capacitor	231877-1756
C-307	Capacitor	231877-2005
C-308	Capacitor	10-231853-561
C-309	Capacitor	231922-205
CR-301	Semiconductor, 1N816	231869
CR-302	Semiconductor	231869
Q-301	Transistor, 2N1372	231885
Q-302	Transistor, 2N1372	231885
Q-303	Transistor, 2N1372	231885
R-301	Resistor	1-128182-2702
R-302	Resistor	1-128182-1502
R-303	Resistor	5-115557-122
R-304	Resistor	5-115557-222
R-305	Resistor	1-128182-4701
R-306	Resistor	1-128182-4701
R-307	Resistor	1-128182-7000
R-308	Resistor	50-128182-1581
R-309	Resistor	5-115557-224
R-310	Resistor	1-128182-1002
R-311	Resistor	1-128182-2202
R-312	Resistor	1-128182-5002
R-313	Resistor	1-128182-2003
R-314	Resistor	1-128182-2003

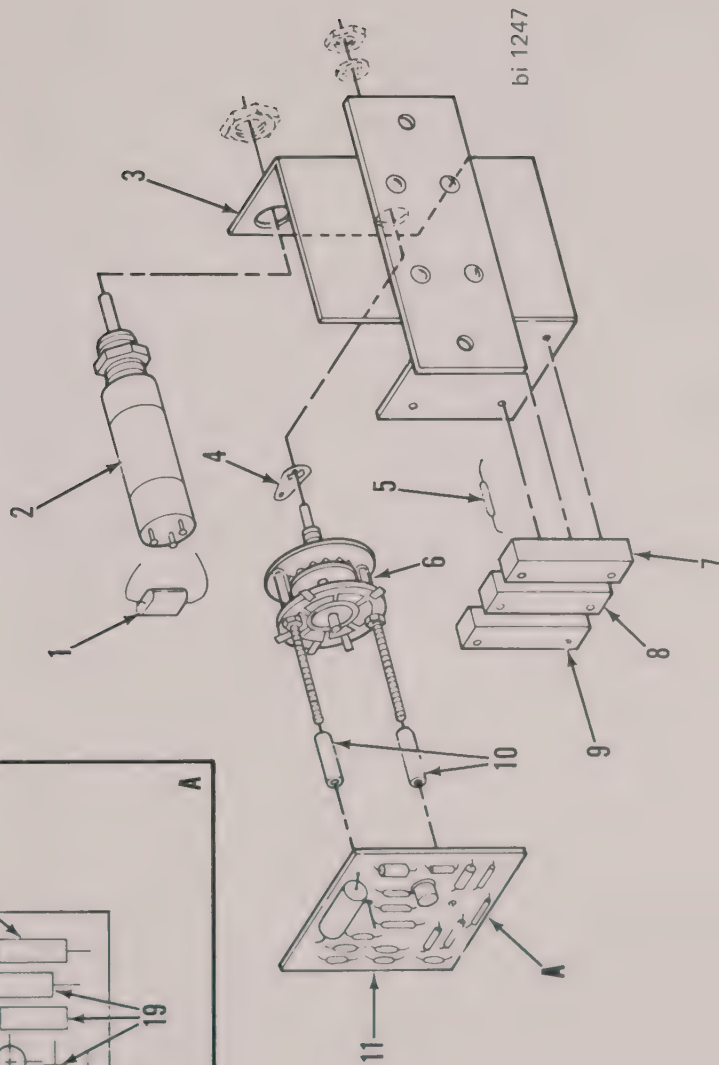
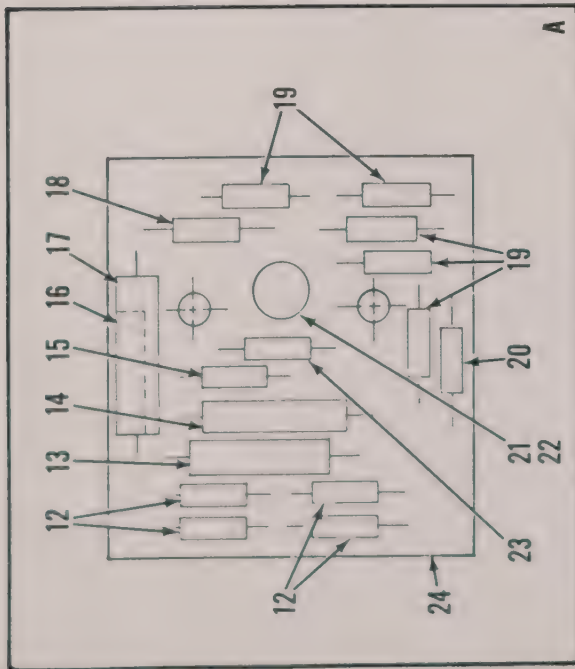


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AMPLIFIER ASM,
PREAMPLIFIER OUTPUT 843879 – Figure 9-15

EXPLODED VIEW PARTS LIST
RIGHT ZERO SUPPRESSION ASM 764147 — Figure 9-16

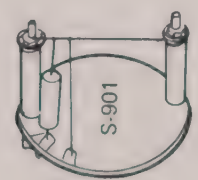
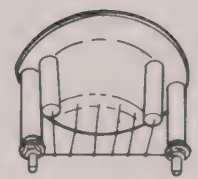
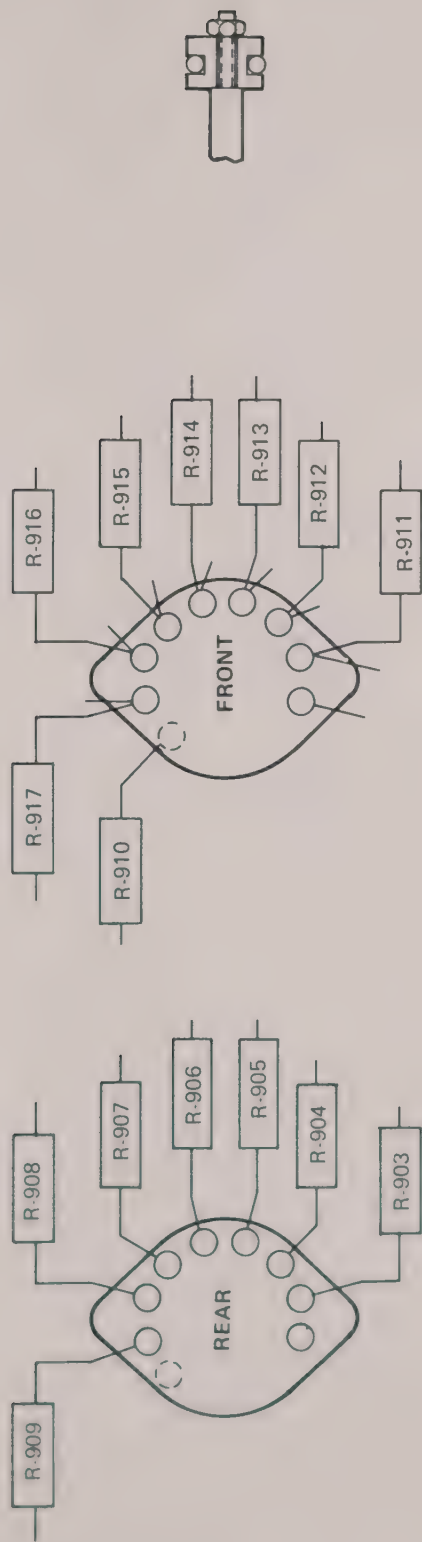
REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Capacitor	2432228-356	C-10
2	Resistor, Variable	245949	R-17
3	Bracket Asm, RH	645291	
4	Lug, Soldering	11528-21	
5	Resistor	50-128182-7501	R-16
6	Switch, Rotary	446368	S-1
7	Resistor	243379-104	R-18
8	Resistor	243380-502	R-15
9	Resistor	243380-102	R-14
10	Spacer	246548	
11	Network Asm	746402	
12	Semiconductor	231887	CR-708 thru CR-711
13	Resistor	1-128182-1001	R-704
14	Resistor	1-128182-1002	R-702
15	Semiconductor	246424	CR-706
16	Label	343606-34	
17	Capacitor	231922-505	C-701
18	Resistor	5-115557-221	R-701
19	Semiconductor	244311	CR-701 thru CR-705
20	Resistor	5-115557-151	R-703
21	Transistor	231884	Q-701
22	Pad, Mounting	231978	
23	Semiconductor	231869	CR-707
24	Eyelet Asm	746403	



ZERO SUPPRESSION ASM 764147 -- Figure 9-16

FIGURE 9-17 — EXPLODED VIEW PARTS LIST
SWITCH ASSEMBLY 746663

SYMBOL NO	DESCRIPTION	PART NUMBER
R-903	Resistor	50-128182-3000
R-904	Resistor	50-128182-5000
R-905	Resistor	50-128182-1501
R-906	Resistor	50-128182-3001
R-907	Resistor	50-128182-5001
R-908	Resistor	50-128182-1502
R-909	Resistor	50-128182-3002
R-910	Resistor	5-115557-151
R-911	Resistor	50-128182-1500
R-912	Resistor	50-128182-4500
R-913	Resistor	50-128182-7500
R-914	Resistor	50-128182-1501
R-915	Resistor	50-128182-4501
R-916	Resistor	50-128182-7501
R-917	Resistor	50-128182-1501
S-901	Switch, Rotary	446387

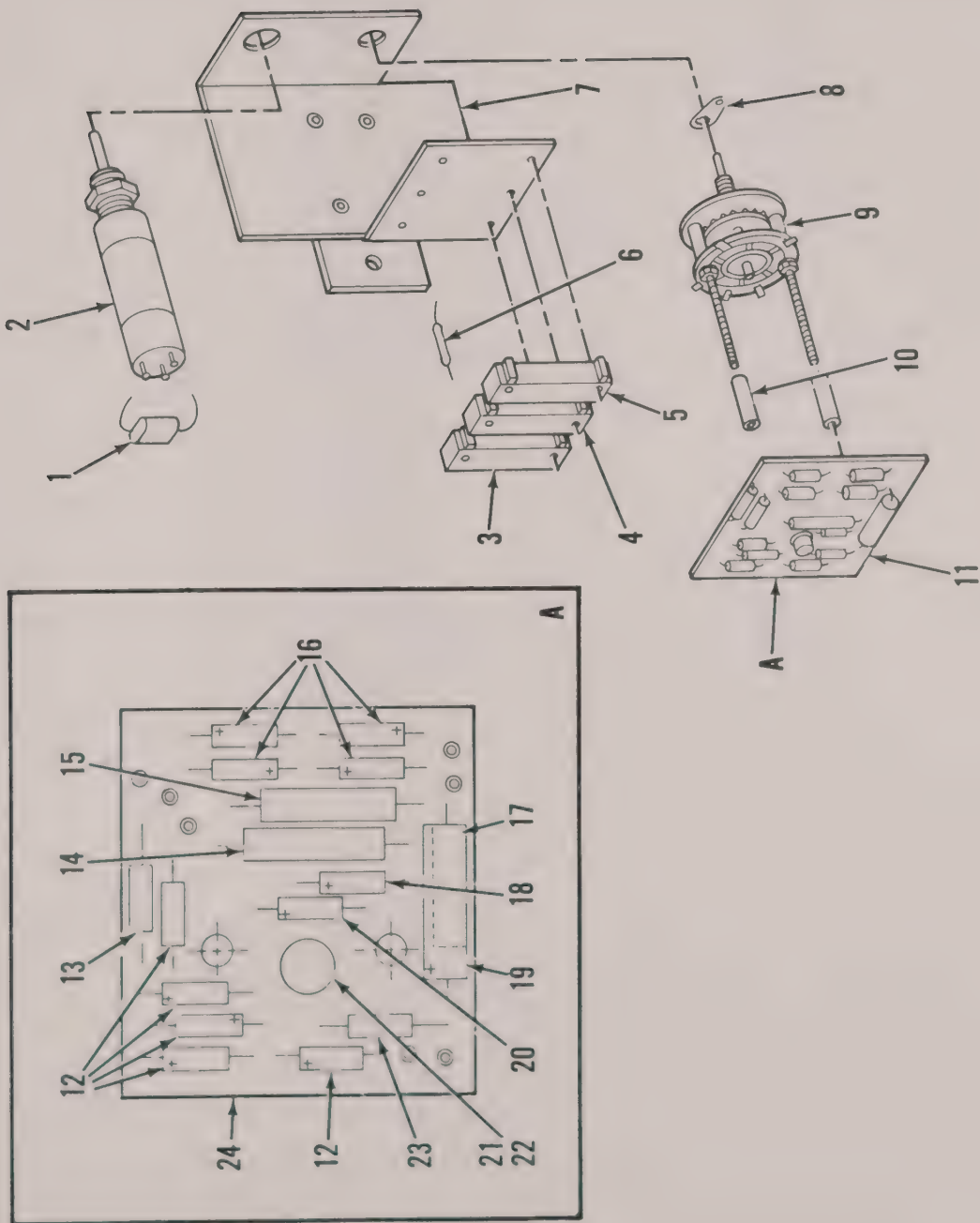


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SWITCH ASM 746663 – Figure 9-17

EXPLODED VIEW PARTS LIST
LEFT ZERO SUPPRESSION ASM 764145 – Figure 9-18

REF NO	DESCRIPTION	PART NUMBER	SYMBOL NO
1	Capacitor	243228-356	C-11
2	Resistor, Variable	245949	R-17
3	Resistor	243379-104	R-18
4	Resistor	243380-502	R-15
5	Resistor	243380-102	R-14
6	Resistor	50-128182-7501	R-16
7	Bracket Asm, LH	645290	
8	Lug, Soldering	11528-21	
9	Switch, Rotary	446368	S-6
10	Spacer	246548	
11	Network Asm	746402	
12	Semiconductor	244311	CR-701 thru CR-705
13	Resistor	5-115557-151	R-703
14	Resistor	1-128182-1002	R-702
15	Resistor	1-128182-1001	R-704
16	Semiconductor	231887	CR-708 thru CR-711
17	Capacitor	231922-505	C-701
18	Semiconductor	246424	CR-706
19	Label	343606-34	
20	Semiconductor	231869	CR-707
21	Transistor	231884	Q-701
22	Pad, Mounting	231978	
23	Resistor	5-115557-221	R-701
24	Eyelet Asm	746403	

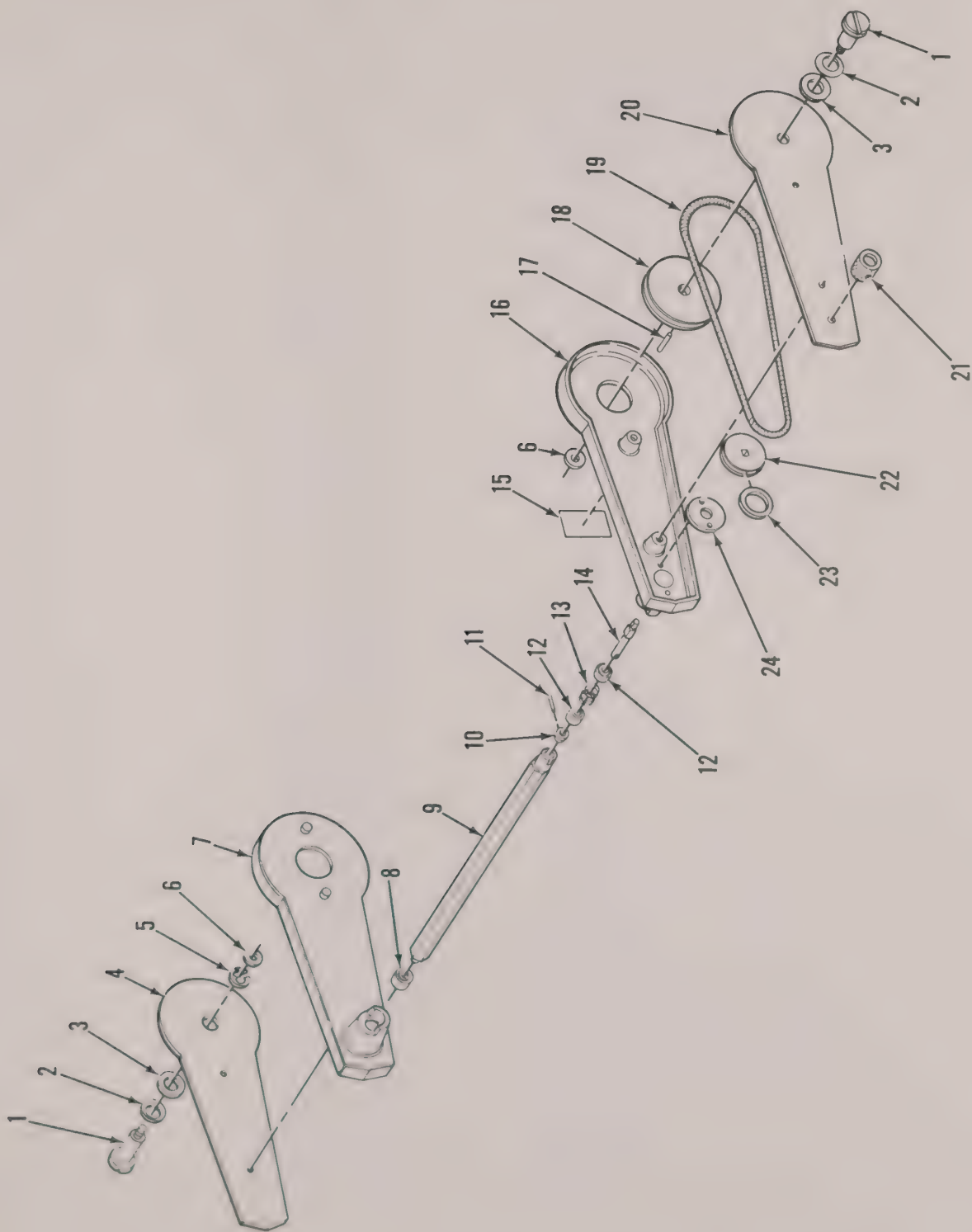


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ZERO SUPPRESSION ASM 764145 — Figure 9-18

EXPLODED VIEW PARTS LIST
CHART TAKEUP ASM 11-6402-00 — Figure 9-19

REF NO	DESCRIPTION	PART NUMBER
1	Screw, Shouldered	243737
2	Spring, Flat	111360-3
3	Washer	243950
4	Plate, Cover Left	343722-1
5	Ring, Retaining	10-127657-6
6	Washer, Plain	128967-2
7	Arm, Takeup Left	343770-1
8	Bearing, Ball	1-210761-7
9	Shaft Subasm, (Includes Item 8)	644026
10	Collar, Shaft	243740
11	Pin, Roll	4-112468-14
12	Bearing, Ball	1-210761-7
13	Spring, Helical	243862
14	Shaft, Shouldered	243741
15	Plate, Ident	243192
16	Arm, Takeup	343768-1
17	Pin, Roll	4-112468-8
18	Pulley	343686
19	Spring, Belt	243838
20	Plate, Cover	243720-1
21	Knob	243688
22	Pulley, Driven	243738
23	Packing, Preformed	243844-1
24	Retainer, Bearing	243696



bi 1235

CHART TAKEUP ASM 11-6402-00 – Figure 9-19

ELECTRICAL PARTS LIST
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
B-1	344070	Motor, A.C., Synchronous (used in Mark 280-01, -10)
B-1	346909	Motor, A.C., Synchronous (alternate for 344070)
B-1	347415	Motor, A.C., Synchronous (alternate for 344070)
B-1	344353	Motor, A.C., Synchronous (used in Mark 280-05,-15)
B-1	347248	Motor, A.C. Synchronous (alternate for 344353)
B-1	363466	Motor, A.C., Synchronous (used in Mark 280-06,-16)
B-1	349087	Motor, A.C., Synchronous (used in Mark 280-04,-14)
B-703	866010	Motor, A.C., Gear Head, 60 cps (used in Mark 280-01,-10)
B-703	746052	Motor, A.C., Gear Head, 50 cps (used in Mark 280-05,-15)
B-703	663632	Motor, A.C., Gear Head, 50 cps 230 volts (used in Mark 280-06,-16)
B-703	863440	Motor, A.C., Gear Head, 400 cps (used in Mark 280-04,-14)
C-10	243228-356	Capacitor
C-11	243228-356	Capacitor
C-49	10-241145-204	Capacitor
C-50	247552	Capacitor
C-51	10-241145-503	Capacitor
C-52	128020-507	Capacitor
C-54	10-241145-104	Capacitor
C-55	10-241145-104	Capacitor
C-60	10-241145-104	Capacitor
C-61	243091-305	Capacitor (used with 344070 and 344353)
C-61	243092-405	Capacitor (used with motor 346909)
C-61	243091-505	Capacitor (used with motor 347415)
C-61	243091-605	Capacitor (used with motor 347248)
C-61	263395-205	Capacitor (used with motor 349087)
C-61	263890-505	Capacitor (used with motor 363466)
C-62	243006-356	Capacitor
C-63	240352-103	Capacitor
C-64	10-241145-104	Capacitor
C-65	10-241145-404	Capacitor
C-66	10-241145-404	Capacitor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER — ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
C-101	10-125904-602	Capacitor
C-102	10-125904-203	Capacitor
C-103	10-125904-602	Capacitor
C-104	10-241145-304	Capacitor
C-105	10-241145-503	Capacitor
C-106	10-125904-102	Capacitor
C-107	10-241145-403	Capacitor
C-108	10-125904-303	Capacitor
C-109	231922-356	Capacitor
C-110	231922-356	Capacitor
C-111	10-125904-332	Capacitor
C-112	10-231854-271	Capacitor
C-113	10-231854-271	Capacitor
C-114	10-125904-332	Capacitor
C-201	241137-2005	Capacitor
C-202	10-231854-560	Capacitor
C-203	10-231853-821	Capacitor
C-204	10-231853-821	Capacitor
C-205	231877-2005	Capacitor
C-206	243228-356	Capacitor
C-301	10-231853-561	Capacitor
C-302	10-231852-162	Capacitor
C-303	10-231853-821	Capacitor
C-304	243228-356	Capacitor
C-305	10-125904-332	Capacitor
C-306	231877-1756	Capacitor
C-307	231877-2005	Capacitor
C-308	10-231853-561	Capacitor
C-309	231922-205	Capacitor
C-401	243006-356	Capacitor
C-402	231922-107	Capacitor
C-403	10-125904-332	Capacitor
C-404	10-125904-332	Capacitor
C-405	10-125904-154	Capacitor
C-406	5-130488-503	Capacitor
C-407	243006-356	Capacitor
C-408	10-241145-143	Capacitor
C-601	243336-304	Capacitor
C-601	10-241145-205	Capacitor (used on Mark 280-04,-14)
C-602	10-241145-105	Capacitor
C-602	10-241145-205	Capacitor (used on Mark 280-04,-14)
C-603	10-241145-105	Capacitor
C-604	231922-256	Capacitor
C-605	1-241145-804	Capacitor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
C-606	10-241145-205	Capacitor
C-606	268585-475	Capacitor (used on Mark 280-04,-14)
C-607	10-241145-404	Capacitor
C-608	10-241145-404	Capacitor
C-609	10-241145-205	Capacitor
C-609	262585-475	Capacitor (used on Mark 280-04,-14)
C-610	10-241145-404	Capacitor
C-611	10-241145-404	Capacitor
C-701	231922-505	Capacitor (used on Mark 280-10,-15)
C-801	231707-207	Capacitor
C-1001	10-241145-503	Capacitor
C-1002	10-241145-503	Capacitor
C-1003	10-241145-503	Capacitor
CR-1	242640	Semiconductor, 1N1124
CR-2	242640	Semiconductor, 1N1124
CR-24	130198-1	Rectifier, Silicon
CR-25	130198-1	Rectifier, Silicon
CR-26	242714	Rectifier, 1N3031
CR-27	242853	Semiconductor Device
CR-28	242853	Semiconductor Device
CR-29	242853	Semiconductor Device
CR-30	242853	Semiconductor Device
CR-101	244311	Semiconductor Device
CR-102	244311	Semiconductor Device
CR-103	244311	Semiconductor Device
CR-104	244311	Semiconductor Device
CR-105	244311	Semiconductor Device
CR-106	244311	Semiconductor Device
CR-107	244311	Semiconductor Device
CR-108	231869	Semiconductor Device
CR-201	244311	Semiconductor Device
CR-202	231869	Semiconductor Device
CR-203	231869	Semiconductor Device
CR-301	231869	Semiconductor, 1N816
CR-302	231869	Semiconductor, 1N816
CR-401	240333	Semiconductor
CR-402	242853	Semiconductor
CR-403	242853	Semiconductor
CR-404	241133	Semiconductor, 1N751A
CR-405	249747	Semiconductor, 1N752A
CR-406	241133	Semiconductor, 1N751A
CR-407	231869	Semiconductor, 1N816
CR-408	231869	Semiconductor, 1N816
CR-409	231869	Semiconductor, 1N816

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
CR-501	244311	Semiconductor, 1N277
CR-502	244896	Semiconductor, 1N458
CR-503	244311	Semiconductor, 1N277
CR-504	244311	Semiconductor, 1N277
CR-505	244896	Semiconductor, 1N458
CR-506	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-701	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-702	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-703	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-704	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-705	244311	Semiconductor, 1N277 (used in Mark 280-10,-15)
CR-706	246424	Semiconductor, 1N759A
CR-707	231869	Semiconductor, 1N816
CR-708	231887	Semiconductor, D1-51
CR-709	231887	Semiconductor, D1-51
CR-710	231887	Semiconductor, D1-51
CR-711	231887	Semiconductor, D1-51
DS-1	1-241774-7	Lamp, Incandescent
F-1	102625-7	Fuse, Quick Acting Type
F-2	102625-2	Fuse, Quick Acting Type
F-4	125470-11	Fuse, Cartridge Time Lag
F-4	116198-10	Fuse (Used in Mark 280-06,-16)
F-5	116198-13	Fuse
F-5	116198-11	Fuse (Used in Mark 280-06,-016)
F-5	116198-33	Fuse (Used in Mark 280-04,-14)
F-601	102625-1	Fuse, Type 3AG (Used in Mark 280-04,-14)
G-1	231753	Chopper, Elec, 4-Pin Plug-in
J-1	114814-7	Jack, Telephone
J-2	244550	Connector
J-3	130168	Connector
J-4	130168	Connector
J-5	130168	Connector
J-6	242011-2	Jack, Tip
L-8	344139	Inductor
L 101	243179	Reactor
L-102	243179	Reactor
L-103	243179	Reactor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER — ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
L-401	242009-1	Coil
L-601	643887-10	Inductor Asm
L-602	243179	Reactor, Audio Freq
L-603	243179	Reactor, Audio Freq
P-1	126295-7	Cable, Connecting
Q-23	243077-4	Transistor, 2N1502
Q-24	243077-4	Transistor, 2N1502
Q-25	243077-4	Transistor, 2N1502
Q-26	243077-4	Transistor, 2N1502
Q-39	243077-4	Transistor, 2N1502
Q-40	243077-4	Transistor, 2N1502
Q-41	243077-4	Transistor, 2N1502
Q-42	243077-4	Transistor, 2N1502
Q-43	243077-4	Transistor, 2N1502
Q-101	231884	Transistor, 2N1370
Q-102	243920-3	Transistor, 2N1193
Q-103	240236	Transistor, 2N1303
Q-104	240237	Transistor, 2N1302
Q-105	240236	Transistor, 2N1303
Q-106	240237	Transistor, 2N1302
Q-107	242323	Transistor
Q-108	242323	Transistor
Q-109	247149	Transistor
Q-110	247149	Transistor
Q-111	242323	Transistor
Q-112	242323	Transistor
Q-113	242323	Transistor
Q-114	243009-28	Transistor, 2N1186
Q-115	243009-28	Transistor, 2N1186
Q-116	242323	Transistor
Q-201	231886	Transistor, 2N1374
Q-202	231884	Transistor, 2N1370
Q-203	231884	Transistor, 2N1370
Q-301	231885	Transistor, 2N1372
Q-302	231885	Transistor, 2N1372
Q-303	231885	Transistor, 2N1372
Q-404	240332	Transistor, 2N1371
Q-405	240332	Transistor, 2N1371
Q-406	231884	Transistor, 2N1370
Q-407	231884	Transistor, 2N1370
Q-408	231884	Transistor, 2N1370
Q-409	243920-3	Transistor, 2N1193

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
Q-501	242323	Transistor
Q-502	242323	Transistor
Q-601	242323	Transistor
Q-602	247347	Transistor, 2N1197
Q-603	247347	Transistor, 2N1197
Q-604	247347	Transistor, 2N1197
Q-605	247347	Transistor, 2N1197
Q-606	243920-4	Transistor, 2N1194
Q-607	242323	Transistor
Q-701	231884	Transistor, 2N1370 (Used in Mark 280,-10,-14,-15,-16)
R-1	R 1-246659-99002	Resistor
R-2	R 1-245853-10101	Resistor
R-3	246393	Resistor, Variable with Switch S-3
R-4	243380-501	Resistor, Variable
R-5	240638	Resistor, Variable
R-6	240638	Resistor, Variable
R-7	5-242300-1R5	Resistor
R-8	5-242300-1R5	Resistor
R-9	243380-202	Resistor, Variable
R-10	5-115557-150	Resistor
R-11	246394-254	Resistor, Variable
R-12	246394-254	Resistor, Variable
R-13	245490-401	Resistor
R-14	243380-102	Resistor (used in Mark 280-10,-15)
R-15	243380-502	Resistor (used in Mark 280-10,-15)
R-16	50-128182-7501	Resistor (used in Mark 280-10,-15)
R-17	245949	Resistor (used in Mark 280-10,-15)
R-18	243379-104	Resistor (used in Mark 280-10,-15)
R-19	5-115559-331	Resistor
R-20	5-115557-472	Resistor
R-101	1-128182-2752	Resistor
R-102	1-128182-5002	Resistor
R-103	1-128182-4092	Resistor
R-105	1-128182-1002	Resistor
R-106	243379-104	Resistor, Variable
R-107	1-128182-4702	Resistor
R-108	5-115557-682	Resistor
R-109	1-128182-3902	Resistor
R-110	5-115557-103	Resistor
R-111	5-115557-123	Resistor
R-112	5-115557-272	Resistor
R-113	1-128182-1003	Resistor
R-114	5-115557-155	Resistor
R-115	1-128182-6802	Resistor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER — ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
R-116	1-128182-2504	Resistor
R-117	1-128182-2003	Resistor
R-118	243379-203	Resistor, Variable
R-119	5-115557-101	Resistor
R-120	1-128182-1002	Resistor
R-121	1-128182-1002	Resistor
R-122	1-128182-1002	Resistor
R-123	1-128182-1002	Resistor
R-124	5-115557-102	Resistor
R-125	243379-203	Resistor
R-126	243379-203	Resistor, Variable
R-127	1-128182-6802	Resistor
R-128	5-115557-332	Resistor
R-129	1-128182-4702	Resistor
R-130	1-128182-3502	Resistor
R-131	1-128182-3502	Resistor
R-132	1-128182-4702	Resistor
R-133	1-128182-1502	Resistor
R-134	1-128182-1502	Resistor
R-135	1-128182-1001	Resistor
R-136	1-128182-1001	Resistor
R-137	5-115557-222	Resistor
R-138	5-115557-390	Resistor
R-139	50-128182-3030	Resistor
R-140	50-128182-3030	Resistor
R-141	5-115557-390	Resistor
R-142	5-115557-222	Resistor
R-148	5-115557-911	Resistor
R-201	5-115557-272	Resistor
R-202	1-128182-3602	Resistor
R-203	1-128182-3602	Resistor
R-204	1-128182-1802	Resistor
R-205	1-128182-9001	Resistor
R-206	5-115557-182	Resistor
R-207	5-115557-182	Resistor
R-208	50-128182-56R0	Resistor
R-209	1-128182-3002	Resistor
R-210	1-128182-3902	Resistor
R-211	1-128182-1303	Resistor
R-212	1-128182-3602	Resistor
R-213	1-128182-3602	Resistor
R-301	1-128182-2702	Resistor
R-320	1-128182-1502	Resistor
R-303	5-115557-122	Resistor
R-304	5-115557-222	Resistor
R-305	1-128182-4701	Resistor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
R-306	1-128182-4701	Resistor
R-307	1-128182-7000	Resistor
R-308	50-128182-1581	Resistor
R-309	5-115557-224	Resistor
R-310	1-128182-1002	Resistor
R-311	1-128182-2202	Resistor
R-312	1-128182-5002	Resistor
R-313	1-128182-2003	Resistor
R-314	1-128182-2003	Resistor
R-401	5-115557-273	Resistor
R-402	5-115558-470	Resistor
R-403	5-115557-272	Resistor
R-404	5-115557-181	Resistor
R-405	5-115557-181	Resistor
R-406	240539-501	Resistor, Variable
R-407	5-115558-152	Resistor
R-408	5-115557-333	Resistor
R-409	5-115557-333	Resistor
R-410	5-115557-103	Resistor
R-411	5-115557-103	Resistor
R-412	5-115557-331	Resistor
R-413	5-115557-222	Resistor
R-414	5-115557-562	Resistor
R-415	240539-202	Resistor, Variable
R-416	5-115557-680	Resistor
R-417	5-115557-120	Resistor
R-419	5-115557-331	Resistor
R-419	5-115557-562	Resistor
R-420	5-115557-123	Resistor
R-501	1-128182-91671	Resistor
R-502	1-128182-1103	Resistor
R-503	244771-502	Resistor, Variable
R-504	244771-502	Resistor, Variable
R-505	5-115557-822	Resistor
R-506	5-115557-122	Resistor
R-507	5-115557-472	Resistor
R-601	1-128182-9001	Resistor
R-601	235724-502	Resistor (used in Mark 280-04,-14)
R-602	5-115557-820	Resistor
R-602	235724-502	Resistor, Variable (used in Mark 280-04,-14)
R-603	248813-202	Resistor, Variable
R-603	5-115557-821	Resistor (used in Mark 280-04,-14)
R-604	1-128182-9001	Resistor
R-604	5-115558-222	Resistor (used in Mark 280-04,-14)
R-605	5-115557-820	Resistor

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

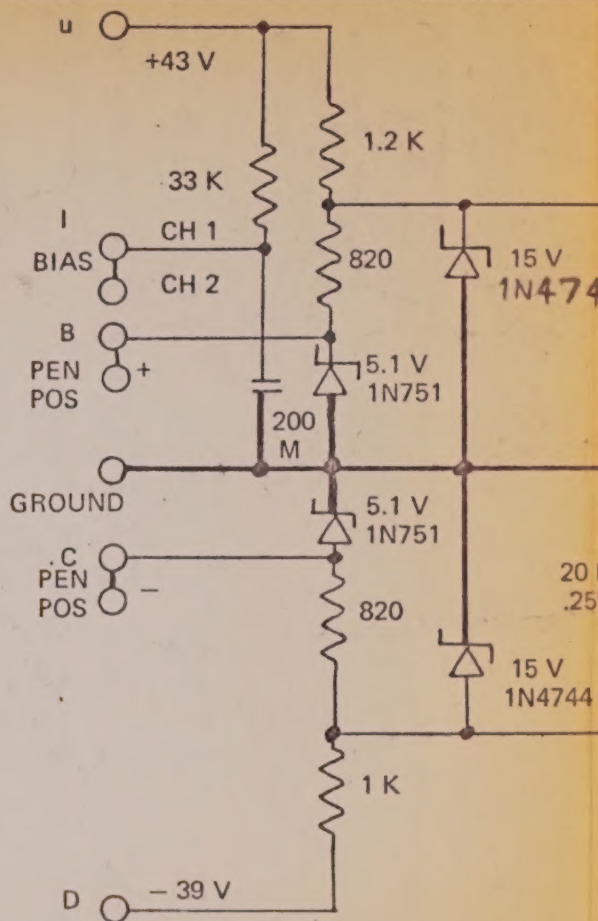
SYMBOL NO	PART NUMBER	DESCRIPTION
R-606	5-119370-102	Resistor
R-607	5-115557-821	Resistor
R-608	5-115557-392	Resistor
R-609	5-115557-122	Resistor
R-610	5-115557-392	Resistor
R-611	5-115557-122	Resistor
R-612	1-128182-1002	Resistor
R-613	1-128182-1501	Resistor
R-614	1-128182-5600	Resistor
R-615	1-128182-1001	Resistor
R-701	5-115557-221	Resistor (used in Mark 280-10,-15)
R-702	1-128182-1002	Resistor (used in Mark 280-10,-15)
R-703	5-115557-151	Resistor (used in Mark 280-10,-15)
R-704	1-128182-1001	Resistor (used in Mark 280-10,-15)
R-801	1-128182-3301	Resistor
R-802	5-115557-333	Resistor
R-803	1-128182-1001	Resistor
R-903	50-128182-3000	Resistor
R-904	50-128182-5000	Resistor
R-905	50-128182-1501	Resistor
R-906	50-128182-3001	Resistor
R-907	50-128182-5001	Resistor
R-908	50-128182-1502	Resistor
R-909	50-128182-3002	Resistor
R-910	5-115557-151	Resistor
R-911	50-128182-1500	Resistor
R-912	50-128182-4500	Resistor
R-913	50-128182-7500	Resistor
R-914	50-128182-1510	Resistor
R-915	50-128182-4501	Resistor
R-916	50-128182-7501	Resistor
R-917	50-128182-1501	Resistor
S-1	446368	Switch, Rotary - 5 Position (used in Mark 280-10,-15)
S-2	231861-910	Switch Asm
S-3	246393-303	Switch with Variable Resistor R-3
S-4	234028	Switch, Toggle, SPST
S-5	128004	Switch, Sensitive, SPDT
S-6	234028	Switch, Toggle SPST
S-7	244302	Switch
S-8	244302	Switch
S-9	246422-1	Switch, Push
S-10	246422-1	Switch, Push

ELECTRICAL PARTS LIST (continued)
MARK 280 RECORDER – ALL MODELS

SYMBOL NO	PART NUMBER	DESCRIPTION
S-901	446387	Switch, Rotary
S-1001	446357	Switch
T-1	232223	Transformer
T-7	344138	Transformer
T-9	243839	Transformer
T-101	243590-910	Transformer Asm
T-401	243188	Transformer, 20 KC
T-601	346459	Transformer
T-602	232354	Transformer
T-603	232346	Transformer (used in Mark 280-04,-14)
TB-1	2-112429-12	Terminal Board
TB-2	265814-4	Terminal Board

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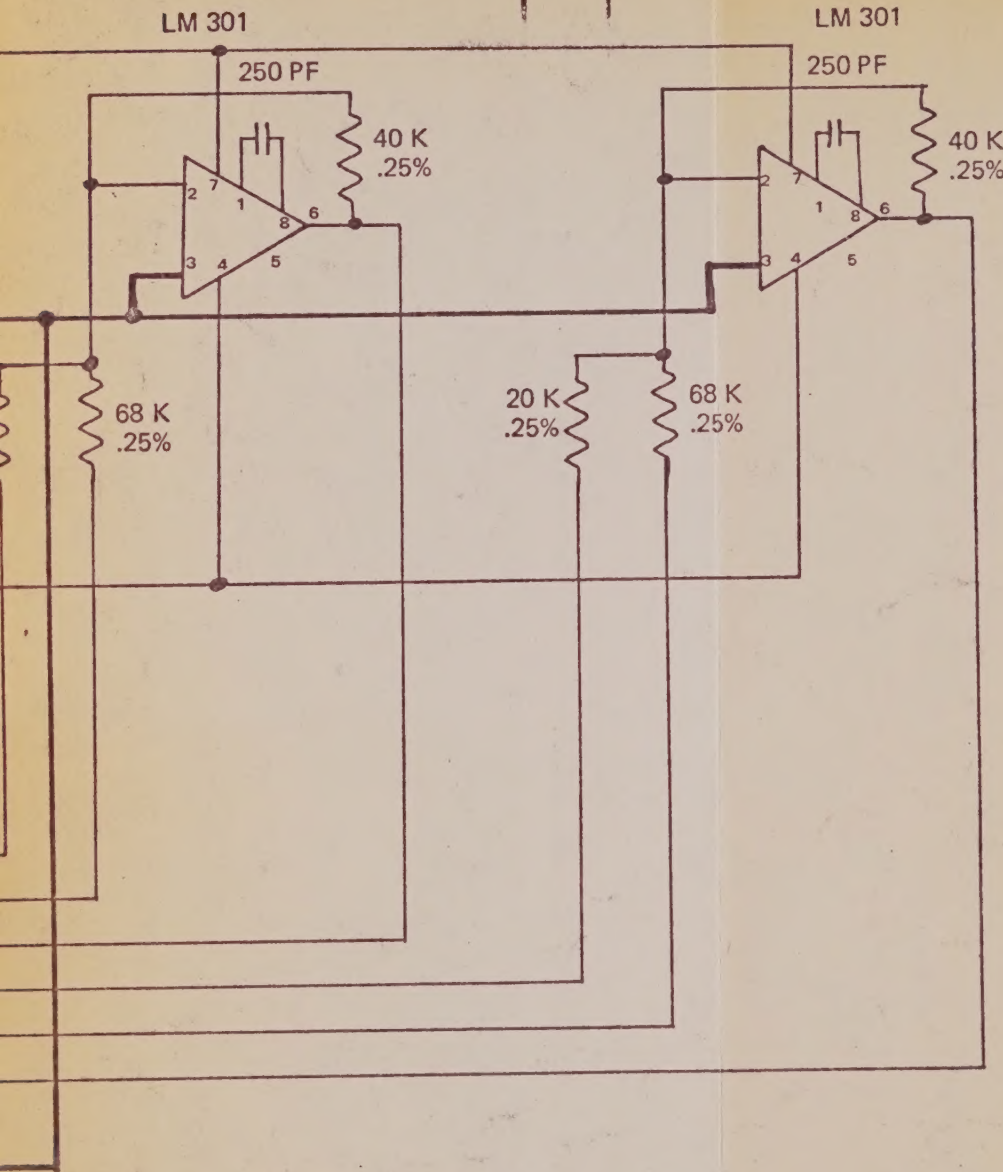


- K ○ SIGNAL IN CH 2
 - J ○ PEN POSITION IN CH 2
 - L ○ SIGNAL OUT CH 2
 - F ○ SIGNAL IN CH 1
 - A ○ PEN POSITION IN CH 1
 - E ○ SIGNAL OUT CH 1
 - H ○ CAL CHECK
 - G ○
- +5 V 3.3 K .5% 2 K 10% 1 K .5%

REOD	ITEM	PART NUMBER
NSP-1374	UNLESS OTHERWISE SPECIFIED	
	DIMENSIONS ARE IN INCHES	
	AND INCLUDE PLATING	
	.XXX = ± .005	SURFACE FINISH
	.XX = ± .015	FINISH
	.X = ± .06	ANGLES = ± 0° 30'
	MATL.	
FIRST USE		

REVISIONS

SYM.	DESCRIPTION	DATE



DESCRIPTION

REMARKS

CML

LIST OF MATERIAL

BY R. G. MORRIS	DATE 10/27/71	NAME SCHEMATIC	Gould Inc. Instrument Systems Division Cleveland, Ohio 44114 U.S.A.
PP. Little	10/27/71	280 MOD.	DWG. NO. 282399
DD. FIN.	FED. CODE NO. 96795	ISSUE CODE	
	SCALE		

282399

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